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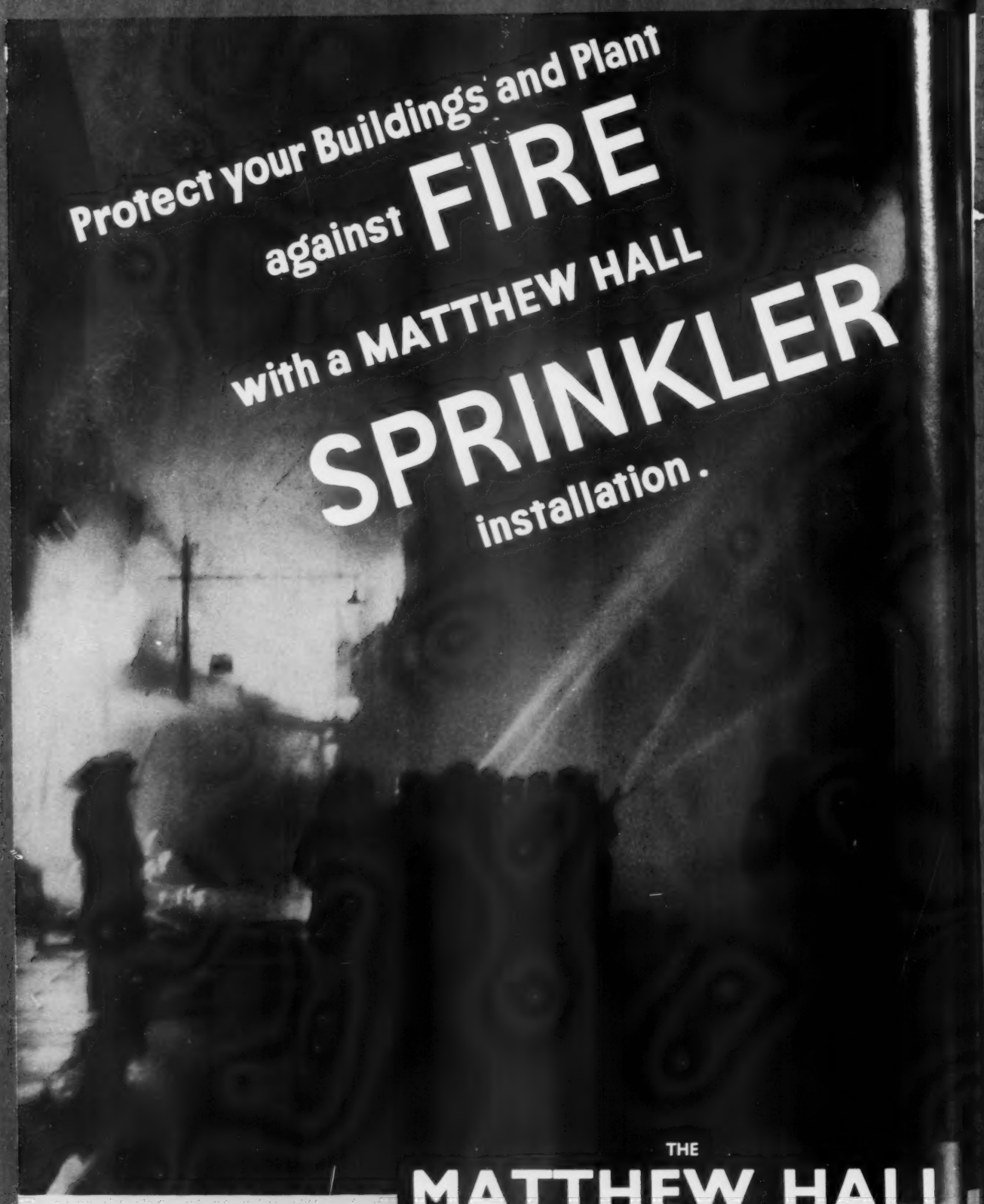

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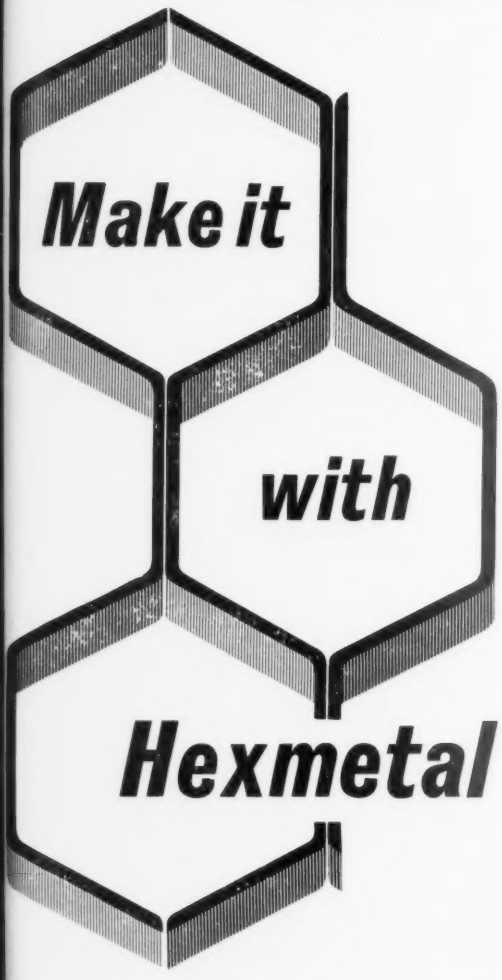

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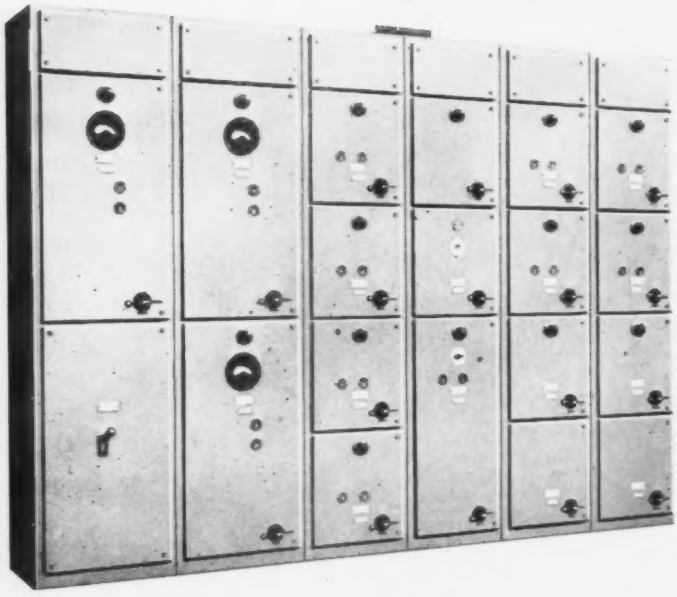

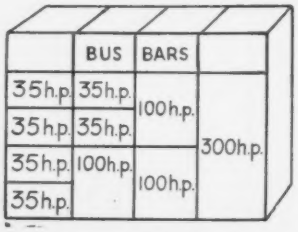

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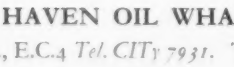

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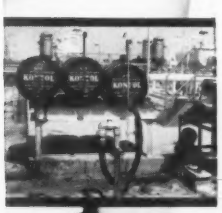

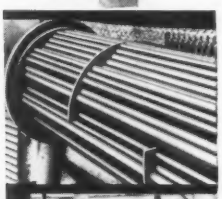

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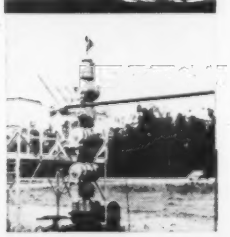

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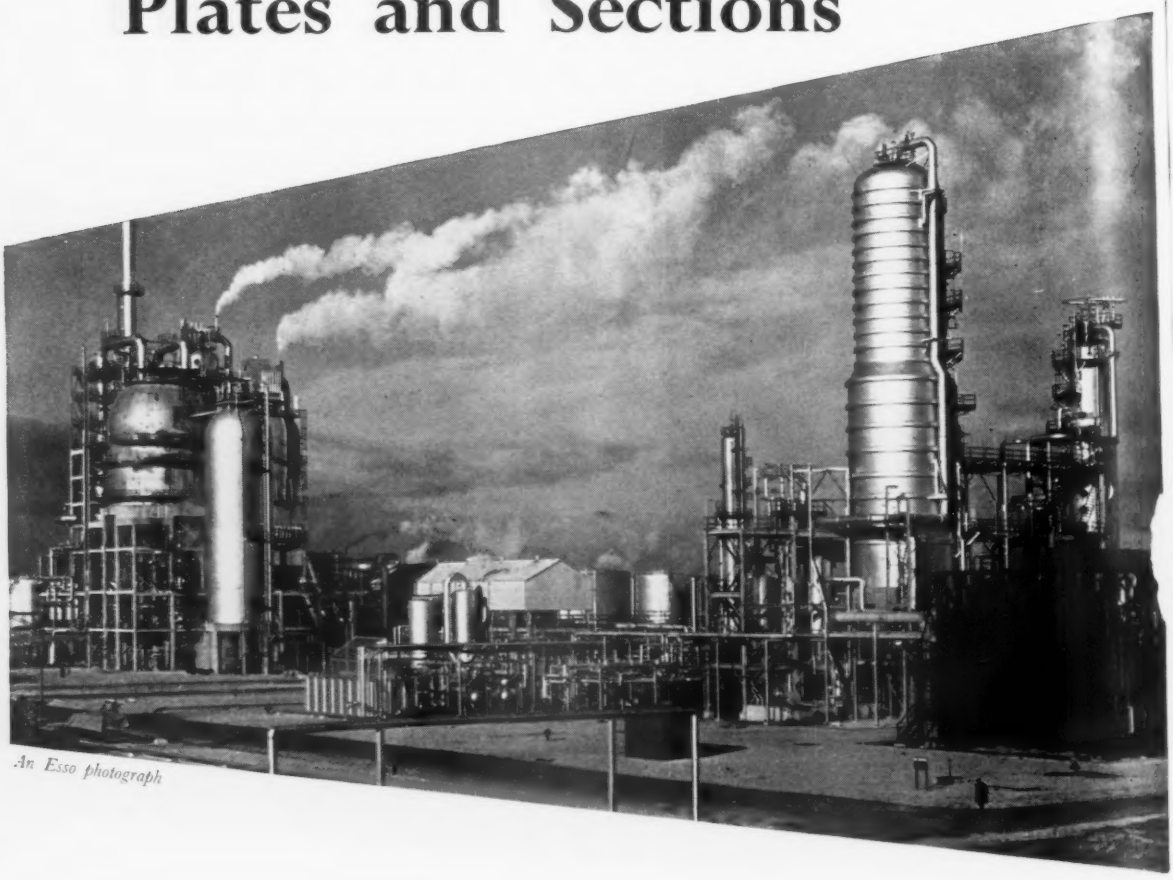

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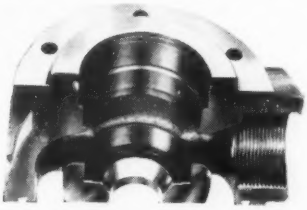

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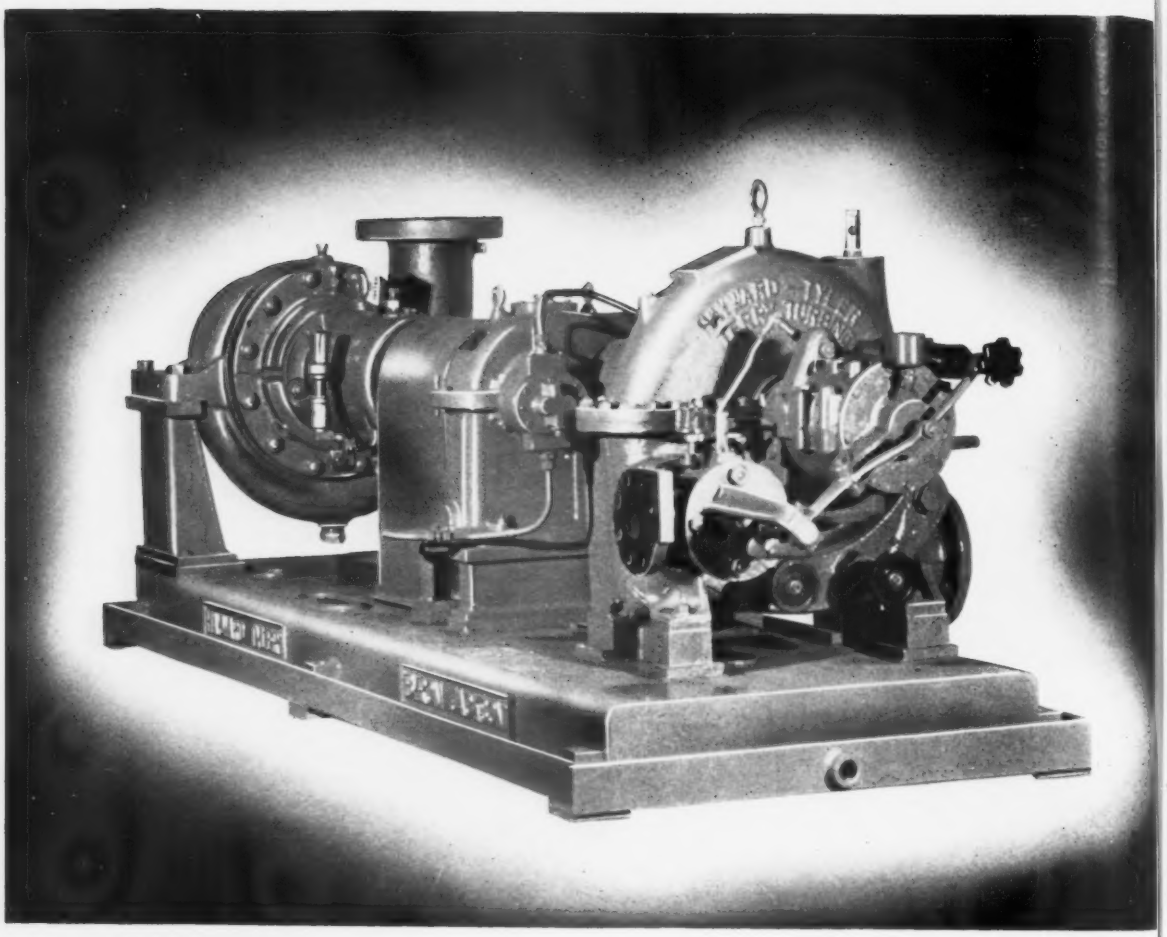

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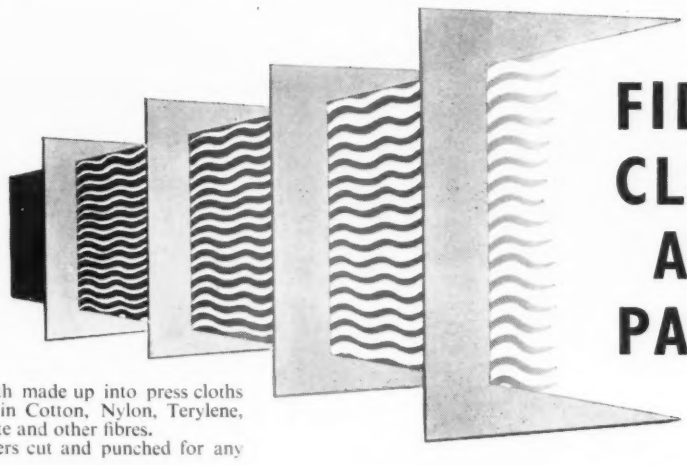

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*The Fuel Economics of Public Road Transport**

By A. T. WILFORD (Fellow)†

There is always a difficulty in presenting a paper of this sort during the early weeks of a year, because recourse must be made to statistics which may seem to be a little out-of-date. The objection is however more apparent than real, and attention will therefore be at once directed to the British Transport Commission's Annual Report and Accounts for 1956.

Volume II—Financial and Statistical Accounts—contains a great amount of valuable information relating to the operations of the various organizations controlled by the Commission. Data are given on British Road Services and the road passenger services operated by the Tilling Group, the Scottish Groups, and London Transport. Table I is derived from this source, and shows the fuel costs in relation to working expenses for each of these four undertakings. There are many differences between the undertakings that do not enter into this paper, but each undertaking has this in common that the proportion of its working expenses attributable to fuel is of the same order in each.

The following remarks relate mainly to London Transport's experience, but their more general application will be obvious.

It is estimated that London Transport's fuel bill for 1958 will be approximately £5·9 million, and taking the price of derv fuel in bulk at 3s. 10d. per gallon (price including tax in effect on 15 January 1958, as quoted in *The Petroleum Times*), it can be readily shown that very nearly £3·9 million will represent tax, the remaining £2 million being the basic cost of the fuel. A change in price of ¼d per gallon would correspond to a change of about £32,000 in the year's fuel bill. An increase in consumption due to a worsening of London Transport's milage per gallon figure by 1 per cent would cost the Executive £59,000 for the year, of which £39,000 would represent tax.

Although continuous efforts are made to economize in the consumption of fuel, it is obvious that this cannot be the prime consideration of a road passenger undertaking which is required to provide a service to the public, nor of a goods-vehicle operator, who is concerned with conveying a wide variety of commodities from place to place in the minimum practicable time. It is only within the framework of the routes and services that economies are possible. It is feasible, and of course highly desirable, to take advantage of changes in design, whether of the mechanical units or the body of the vehicle, which will lead to a reduction in fuel costs. But it is not possible to avoid operating in heavily congested and busy areas just because fuel consumption is likely to be excessive.

Examples of the wide variations in fuel consumption of vehicles on different routes in London Transport's central area are given in Table II. The figures were not all obtained at the same point in time, and have therefore been adjusted to correspond with the mean fleet consumption figure for the year 1955. The reasons for the variations will be discussed later, though it may be noted that the difference between the "easiest" and—with one exception—the "hardest" route amongst these few examples amounts to more than 45 per cent. Thus, buses operating on route 71 use nearly one third less fuel than buses on route 8A for the same distance travelled. There is little or nothing that London Transport can do about this great variation, though this does not prevent the Executive from making a close study of factors which affect fuel consumption. Such information is in fact vitally necessary, not only as an aid to effecting economies where possible, but also to permit an intelligent interpretation of the figures, and so avoid expenditure of effort and perhaps money, in unprofitable directions.

*Read at a meeting of the IP Economics and Operations Group on 13 February 1958.

†London Transport Executive.

TABLE I

FUEL COSTS IN RELATION TO TOTAL WORKING EXPENSES

	Fuel £	*Total working expenses* £	*Fuel costs expressed as percentage of total working expenses*
British Road Services	6,561,240*	46,724,120	14·0
Tilling Group ...	5,355,021*	35,459,653	15·1
Scottish Group ...	3,019,151*	16,704,703	18·0
London Transport ...	5,831,377†	44,408,869	13·1

*Petrol and derv. †Derv only.

The fuel consumption of an internal combustion engined vehicle is affected by a number of factors which can be grouped under the following headings:—

(i) Vehicle characteristics (*i.e.* design of engine and other mechanical units, unladen weight, seating capacity, or, in the case of a goods vehicle, payload).

(ii) Overall vehicle efficiency.

(iii) Operating conditions, including passenger loadings and standard of driving.

(iv) Weather conditions.

(v) Lubricating oil and fuel characteristics.

There is no particular significance in the order in which the groups of factors have been listed, lubricating oil and fuel characteristics being placed last solely for the reason that such placing permits a logical development of the subject of this talk. The effects of these factors will be reviewed in some detail.

Vehicle Characteristics

The benefits obtained from the use of the high-speed compression ignition engine in place of a spark-ignition engine in public service and heavy goods vehicles are well known, and when the change was first made, now nearly 30 years ago, there was a reduction in fuel consumption approaching 50 per cent. At a later date the adoption of the direct-injection design in place of the indirect-injection engine resulted in a further 10 per cent saving in fuel. The high-speed diesel engine is more expensive in first cost than a petrol engine of equivalent output, but it is more robust and reliable, and it can be shown that with an annual milage as low as 15,000, the running costs of a 6-ton lorry are at least £100 per annum lower than those of a similar petrol-driven vehicle. It can be conceded that the development and subsequent availability of high-octane petrols have led to the production of spark-ignition engines of much higher compression ratio than was formerly the case, with consequent reduction in fuel consumption. But even so, the most modern petrol engine is not capable of competing with the road diesel engine in running costs. The development of diesel engines of smaller size has rendered it economical to employ this type of prime mover in light goods vehicles and in taxi-cabs.

TABLE II

EXAMPLES OF ROUTE FUEL CONSUMPTION

(Double-deck buses—central area. Adjusted to 1955 standard)

Route No.	*Destination*	*Fuel consumption: mpg*
8A	Old Ford and London Bridge Station ...	8·0
9	Liverpool Street Station and Mortlake ...	8·6
13	London Bridge Station and Golders Green	8·8
25	Victoria Station and Becontree Heath ...	9·3
43	London Bridge and Friern Barnet ...	7·3
71	Brook Green and Kingston	11·6
112	Palmers Green and Ealing Broadway ...	10·0
183	Golders Green and Northwood ...	9·8
270	Kensington and Teddington	10·8
	Mean fleet consumption (all routes):	9·5

Fuel consumption is affected also by the design of the transmission unit and all London's buses and some provincial ones also are equipped with fluid flywheels and pre-selective gear boxes. Although this form of transmission increases fuel consumption by not less than 5 per cent, the expenditure on fuel is recouped by a corresponding reduction in maintenance costs compared with a clutch-driven transmission unit. Furthermore, the fluid transmission gives enhanced vehicle riding qualities and eases the job of the driver, a matter of considerable importance in the strenuous conditions encountered in driving buses in London traffic.

An overdrive is amongst the mechanical features which can lead to a significant reduction in fuel consumption, though unfortunately not under London traffic conditions. The scope for the use of such a feature in buses operating on country routes is however under consideration. Fuel can also be saved by the use of an appropriate rear axle ratio, though here again with a large fleet of vehicles operating in urban areas the scope is somewhat restricted if full interchangeability of vehicles between routes is to be maintained. There is however more latitude for varying rear axle ratio to suit route conditions in the case of coaches and for buses operating in the country.

Fuel consumption is affected by the unladen weight of the vehicle. The effect of weight varies with speed and frequency of stopping and for a bus operating under average conditions of loading, speed, and stopping in London, each ton of weight increases fuel consumption by 7·3 per cent, and a reduction produces a comparable economy. It will be appreciated therefore that much interest is being shown in light-alloy construction. With a legal restriction on maximum laden weight, a reduction in unladen weight permits the use of a public service vehicle with increased seating capacity or if it be a goods vehicle, increased payload. In such circumstances the same amount of fuel may be consumed so the saving will appear in overall operating costs. It is, however, worthy of mention that London Transport's new RM bus, which is to replace the existing trolleybuses, will provide seats for 64 passengers and is expected to yield a fuel consumption figure lower than that of the present RT bus which seats 56 passengers. This improvement is due in part to the use of light alloys, though mechanical changes also contribute.

Overall Vehicle Efficiency

It is perhaps sufficient to say under this heading that the full benefits of improvements aimed at reducing fuel consumption cannot be achieved unless the vehicle is maintained at a high standard of efficiency. It is therefore necessary to adopt a system of planned maintenance both at garages and at the central overhaul establishment (if the operator undertakes

TABLE III

ANALYSIS OF VEHICLES RECORDED AT 117 POINTS IN LONDON

Derived from the Metropolitan and City of London Police Census of Traffic—1956)

Class of vehicle	*Number of each class as percentage of total*
Private cars	41·17
Light commercial vehicles	23·32
Taxi-cabs	7·63
Pedal cycles	7·47
Buses	*6·70*
Heavy commercial vehicles	4·91
Solo motor cycles	4·56
Motor cycle combinations	1·34
Trolleybuses	0·94
Others	1·96
	100·00

this work himself). It is equally necessary to combine the system with adequate inspection to ensure that the various operations are carried out at the periods laid down and that the procedures are rigidly adhered to.

Operating Conditions

A group of factors largely outside the control of the operator, particularly if he is running an urban bus service, are now considered.

His first consideration must be to cater for the needs of the travelling public. It is therefore essential to provide a fleet of vehicles large enough to deal expeditiously with the morning and evening peaks. From the aspect of fuel consumption, and from other aspects also, many of these vehicles will be inefficiently employed in that they will be called upon to perform short journeys carrying a full load in perhaps only one direction, while for a considerable proportion of the day some of them will be standing idle in the garages. The buses must run through the busiest thoroughfares which the public wish both to reach and leave. The fact that other vehicles, far outnumbering buses, also use these thoroughfares has to be accepted. As will be seen from Table III, buses in London constitute less than 7 per cent of the wheeled traffic on the roads. The proportion is even smaller if account is taken of the numbers of immobile vehicles parked at the sides of the streets. These conditions of working, which are imposed on the operator, are by no means compatible with economy in fuel consumption—very much the reverse.

It will have already been noticed from Table II that a mean fuel consumption of 9·5 mpg for buses running in London Transport's central area (*i.e.* the red buses) conceals a considerable amount of variation and that some routes are much more extravagant in fuel than others. The differences in consumption between routes are due to a variety of causes and in some cases are a reflection of operation under conditions of peak traffic and loadings. This for example is the explanation of the unusually high consumption shown for route 43, on which buses are not operated after 7 p.m. In the main, however, the differences are attributable to differences in running speed (necessitated by the characteristics of the route), average loading, and number of stops per mile, the last two being to some extent inter-related. Having regard to the limited range of speeds within which it is possible to operate in the London area, the number of stops per mile is a most important factor affecting fuel consumption, for on every occasion the vehicle is stopped, kinetic energy is lost which has to be regained by accelerating from rest through the gears.

In the course of experimental work, London Transport have accumulated much data on fuel consumption in relation to speed and frequency of stopping. Some interesting figures derived from carefully controlled tests carried out on the MIRA proving ground are given in Table IV. Average speed in this context corresponds to journey speed, *i.e.* it includes stops; it is not quite the same as scheduled speed which includes lay-over times at terminal points. Stops were uniformly spaced, though this is not always so in service; stopping time was 10 sec for each, a realistic mean figure. Under these conditions of operation with an average speed of 11 mph, fuel consumption with 7 stops per mile was 65 per cent greater than with 2 stops per mile. On the other hand, it was also found, in the same series of tests, that if journey speed was reduced to 9 mph, fuel consumption was at the rate of 10·9 mpg for 7 stops per mile, a decrease of 22 per cent compared with running at 11 mph.

These figures were obtained under somewhat idealized, though not unrealistic, conditions and with particularly skilled drivers who, for this reason and due also to the absence of random traffic, were able to adhere closely to the programme laid down. The recorded fuel consumption figures were therefore lower than those which would be obtained in actual service. Thus, for route 13, which has about 6 stops per mile, the service fuel consumption figure (1955 "standard") is 8·8 mpg. The route is fairly typical of conditions met with in the busy portion of the central area and not all the stops are occasioned by setting down and picking up passengers. An analysis of causes of stopping on this sort of route is given in Table V. A momentary stop from 25 mph costs about 0·6d in fuel, while a 10-sec stop, if not allowed for in the schedule, costs 0·8d. Consumption during idling is quite small and the increase in cost from 0·6d to 0·8d is due to the necessity for accelerating to a higher speed than would otherwise be required, in order to keep to schedule. These cost figures relate only to fuel and are exclusive of wear and tear on tyres, on the engine, and on other mechanical components. From these few facts it is not difficult to see that operation of buses in congested areas with much stopping and starting, often with little likelihood of getting into top gear between stops, must inevitably lead to heavy consumption of fuel.

TABLE IV

FUEL CONSUMPTIONS AT AVERAGE SPEED OF 11 MPH WITH INCREASING NUMBER OF STOPS PER MILE

Stops per mile	*Fuel consumption*	
	Gallons per 100 miles	*Miles per gallon*
2	7·1	14·1
3	7·3	13·7
4	7·6	13·1
5	8·3	12·0
6	9·4	10·6
7	11·7	8·6

TABLE V

ANALYSIS OF STOPS—TYPICAL BUSY ROUTES

Obligatory (fixed) passenger stops ...	2·73 per mile
Request passenger stops	1·66 ,,
Traffic lights	1·05 ,,
Police-controlled Intersections ...	0·12 ,,
Zebra crossings	0·11 ,,
Others	0·55 ,,
	6·22

Annual surveys carried out by the police and by the Road Research Laboratory, who can also provide week-by-week and even daily figures derived from their automatic traffic counters, confirm in a quantitative manner the continuous increase in traffic flow in the central area of London. Its effect on buses has been to render much more difficult the maintenance of regularity of services with the result that intending passengers are likely to walk—and in fact do so—rather than "hop on a bus". Revenue is thus lost and at the same time operating expenses are increased. From a detailed analysis of our fuel consumption records it has been possible to show that the miles per gallon figure has worsened to the extent of approximately 1 per cent per year for some years past, due entirely to the increase in traffic congestion. The relationship between London Transport's fleet mpg figure and traffic flow on certain roads in which Road Research Laboratory counters are installed is quite striking. Put in terms of money, the increase in traffic congestion is costing London Transport an additional £60,000 every year in fuel alone; the total cost is of course much greater.

Improvements in rates of acceleration have enabled scheduled speeds to be maintained despite the continual increase in density of traffic, though fuel costs have been increased. On the other hand, the improvement in acceleration rates has permitted the same frequency of service without increasing the numbers of vehicles and crews. An actual increase in scheduled speeds, if this were possible, could in certain circumstances permit a reduction in the size of the fleet, though it can be shown that above a certain speed—quite unattainable in London traffic—the increase in fuel costs, together with those of wear and tear would outweigh the savings in other directions.

An increase in fuel and other costs associated with an increase in speed might be accepted if it were possible to obtain an increase in revenue due to the improved quality of the service provided. It is quite unlikely that bus passengers could be persuaded to pay higher fares for a reduction in journey time which to the majority of travellers might amount to no more than a few minutes morning and evening. Other considerations might well apply in the case of goods-carrying vehicles travelling over much longer distances where the saving in time might become significant and could justify an increase in charges or would gain traffic from competitors. Even here, however, a careful balance would have to be maintained between the advantages and disadvantages in that the increased need for maintenance would involve capital expenditure in providing additional resources for carrying out more frequent overhauling of the vehicle and mechanical units; the operator would wish to assure himself that the demand for the enhanced service would last long enough to justify the expenditure.

When saying that operating conditions are, in the main, not within the control of the operator, it is not being forgotten that fuel consumption is considerably influenced by driving technique. This subject has been closely studied by London Transport's Research Department and some five years ago a comprehensive series of tests were carried out with a group of buses on the MIRA proving ground. The information so obtained was communicated to the Operating Department and is made use of in training of drivers; supervision in service is exercised by the Department's Mechanical Inspectors. London Transport is not alone in paying attention to the standard of driving and it is carefully watched by all bus operators. The situation is more difficult for goods-vehicle operators, where for obvious reasons it is often impossible to exercise a direct control; nevertheless these operators—or at least the more discriminating ones—are as fuel conscious as are the operators of public service vehicles.

Weather Conditions

Fuel consumption is much affected by weather conditions and in particular by variations in atmospheric temperature. The Executive have found—and it has been confirmed by the statisticians—that an increase of 1° F in mean atmospheric temperature reduces fuel consumption by 0·035 gallons per hundred miles, and of course *vice versa*. Thus, if the mean temperature during 1958 is 1° F lower than it was in 1957, fuel costs, due to this cause alone, will rise by about £20,000. It is a matter of common observation that fuel consumption is also increased by snow and heavy rainfall—good evidence of the latter has been provided by a study of data obtained under test track conditions—but London Transport have so far been unable to quantify these effects in relation to service fuel consumption. The observed increase in consumption during tests carried out when rain is falling is no doubt due to splashing of water on to the bottom of the engine crankcase, thereby cooling the lubricating oil and so leading to a temporary increase in engine friction losses. More will be said about this later.

In the years before the war and immediately afterwards when traffic conditions were less severe and more stable than they are to-day, it was possible in London to demonstrate the close relationship between fuel consumption and mean temperature by plotting the two parameters on a single chart. This is illustrated in Fig 1 which shows, above, fuel consumption at 4-weekly intervals during 1947 and below, the mean atmospheric temperature over the corresponding periods. The relationship is striking. In more recent years, however, the summer peak improvement in fuel consumption has become partially, and sometimes wholly, masked by the effect of the increased amount of traffic on the roads. This is illustrated in Fig 2 which shows fuel consumption—at weekly intervals this time—during 1950. It may be recalled that the early summer of that year saw the end of fuel rationing and there was an immediate large increase in private-car traffic and a consequent increase in congestion on the roads. It may be noticed by comparison with Fig 1 that fuel consumption during the first half of 1950 was at a lower level than during 1947. This was due to the fact that the Executive was already reaping benefit from the adoption of a less viscous grade of engine lubricating oil. As the year went on however, the gain was almost nullified by the effects of increased traffic congestion.

Lubricating Oil and Fuel Characteristics

Amongst the endeavours of road operators to improve fuel consumption, nothing in recent years has been more fruitful than the investigations which led, in the instance of

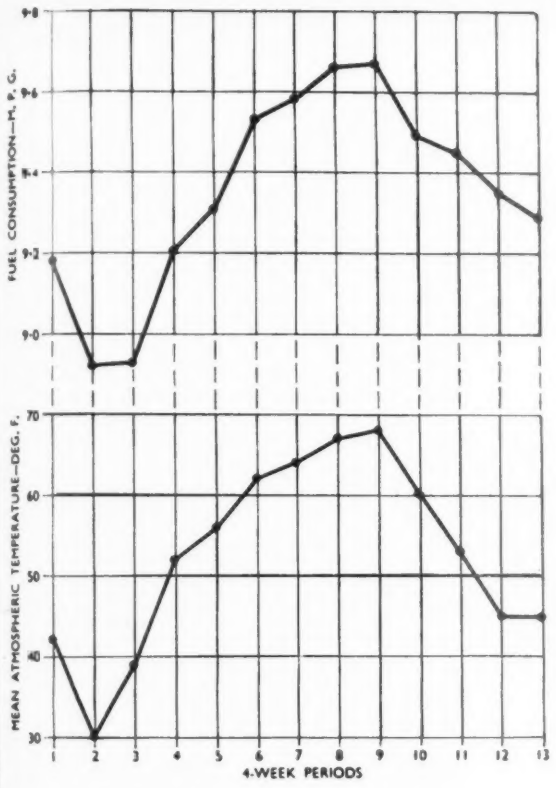

Fig 1. *Central buses fuel consumption in* 1947

London Transport, to the adoption, first of an oil of SAE 20W viscosity in place of the SAE 30 grading which had been the standard lubricant for the diesel-engined fleet almost since its inception. This change, which led to a reduction in engine friction losses, was conclusively proved to have reduced fuel consumption by some 3½ per cent. At a later date the SAE 20 W oil was replaced by one of SAE 10 W viscosity and its use as an "all-the-year-round" lubricant yielded a further saving of 2½ per cent. The total effect of the use of low viscosity oil has therefore been to reduce fuel consumption by 6 per cent with a saving in fuel costs amounting to about £350,000 per annum. This is the minimum saving for there is good evidence that, despite a small off-set due to an increase of about 15 per cent in lubricating oil consumption, life of engines between overhauls has been increased and batteries are also lasting longer.

The savings obtained from the use of low viscosity oil have been equalled, and in some cases bettered, by other operators of public service vehicles. The magnitude of the saving depends to some extent on operating conditions and it seems, from work carried out elsewhere, that greater benefits can be obtained in the provinces, where traffic conditions are less strenuous than in London, and a higher proportion of routes are run over country roads. Lower viscosity oils have also been adopted by some operators of goods vehicles but the scope is not perhaps so great as for public service vehicles on account of the longer periods of running at full load, and the geographical distribution of the vehicles.

Some recent work by London Transport has shown that a further improvement in fuel consumption of not less than 2 per cent, equivalent to a minimum reduction of £120,000 per annum in fuel costs, could be achieved by the use of a rear axle oil of improved lubricity. The various oils which have been tested are also of lower viscosity than the grade at present standardized but London Transport have satisfied themselves that in the rear axle—which is of the worm-driven type—a reduction in viscosity *per se* does not improve fuel consumption. The oils which have shown benefit in comparatively small-scale service tests have been an oxidation-inhibited castor oil, castor oil/synthetic ester blends, and a wholly synthetic oil. Some mechanical difficulties have been encountered in taking advantage of the results of these important investigations but a very large-scale test with one of the lubricants (castor oil) is about to start, and there is no doubt that in course of time the Executive will be able to realize this further saving in fuel costs.

Having said so much about the efforts to reduce fuel consumption and the many adverse factors—most of them being outside the control of the operator—which work in the other direction, it is time to say something about the fuel itself.

The desirable characteristics of a fuel for high-speed diesel engines have been the subject of many papers and there is little need to reiterate them on this occasion. Most operators agree that the middle distillates at present marketed as derv fuels in Britain are basically satisfactory though there might be reservations about sulphur content and certain obscure properties which are thought to have some influence on exhaust smoke emission. A high sulphur content is instinctively disliked but it must be confessed that within the range of sulphur contents represented by fuels currently marketed, there is no published evidence to show that this property has an adverse effect on engine life. On the other hand a small reduction in engine life which cannot be pin-pointed to any particular cause will nevertheless have a significant effect on working expenses and, other things being equal, a low sulphur fuel is bound to be preferred.

It has been stated that when combustion is such that exhaust smoke emission is at an acceptable low level, about 2 per cent of the fuel injected is emitted as unburnt hydrocarbons. This degree of inefficient utilization must probably be attributed to engine design. Any increase in exhaust smoke above this level will be associated with an increase in fuel consumption which becomes very marked when dense black smoke is emitted. This state of affairs can be avoided by proper maintenance though the operator is entitled to object to any characteristics of the fuel which lead to rapid choking of injector nozzles or wear of either the injectors themselves or of the fuel-injection mechanism. Both will

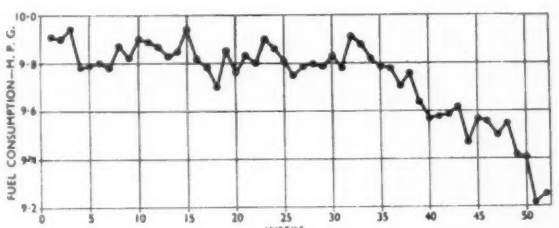

Fig 2. *Central buses fuel consumption in* 1950

cause an increase in fuel consumption and higher maintenance costs.

Fuel costs for a bus running 40,000 miles a year in the London area amount to about £800. A reduction of 1d per gallon in the price to compensate for a deterioration in quality—the figure stated is quite notional—would save £17. Even if fuel consumption were not increased, a sum of £17 per annum would not go very far to meet any increase in maintenance costs which might be necessitated by more frequent attention to injectors and fuel-injection pumps, by replacements of worn components, and by more frequent overhauling of engines.

It is not in this direction—*i.e.*, towards a class B fuel—that a change is feared. Operators are much more sensitive to the possibility of a decrease in fuel specific gravity. Although it is true that the calorific value of the fuel on a weight basis increases with decrease in specific gravity, calorific value per gallon decreases and, over a narrow range at least, fuel consumption increases *pro rata*. A few years ago a derv fuel of s.g. 0·830 was used in buses at two garages for a period of a year. Compared with the remainder of the fleet which continued to use a fuel of mean s.g. 0·848, the increase in consumption was nearly 2 per cent.

There is no difficulty in using a much more volatile fuel in high-speed diesel engines. They can be operated using petrol as fuel and the fuel commonly used for vehicles in city services in the U.S.A. has a specific gravity of about 0·800. The use of such a fuel for public service vehicles operating in Britain would, however, result in a substantial increase in fuel costs; with London Transport it might amount to £350,000 per annum. There seem to be no compensating advantages and the increased cost would have to be met by some adjustment of the fares level or by reducing services.

It is conceivable that suppliers, having regard to the shortage of middle distillates and the comparative abundance of lighter distillates, might be willing to sell a modified grade of derv fuel on the basis of declared calorific value but the price might still have to be related to the basic cost of the fuel, which would continue to bear a tax of 2s 6d per gallon. When the tax was increased to 2s 6d per gallon, the then Chancellor of the Exchequer stated that it would serve as an incentive towards economy in consumption of fuel, as indeed it has. It might be argued that the tax is now producing the amount of revenue required and that the user should not be expected to pay additional tax arising from an increase in consumption due to causes over which he has no control whatever, but such an argument is unlikely to be accepted. Another alternative would be both to market and tax the fuel on a weight rather than a volume basis, but the practical difficulties associated with such a suggestion seem almost insuperable. There can be no doubt that under present conditions and with tax not only at its present level, but at any level, operators must continue to demand a middle distillate fuel of as high a specific gravity as they can get and can use without adversely affecting engine performance.

On the other hand—as has been already shown in this paper—there is no opposition to change just because it is something new or unfamiliar. Experiments are going on all the time and any proposals which would not be expected to have an adverse effect on operating costs would be given serious consideration.

Discussion

The opening speaker thought that, although most operators welcomed high fuel specific gravities, demand and the increasing use of diesels would tend to reduce specific gravities of fuels for road diesels. Lower specific gravities, however, might not raise fuel consumption greatly, because type of operation might have some influence. Mr Wilford doubted if service conditions affected fuel consumption in relation to specific gravity.

The figure of 2 per cent unburnt fuel in the exhaust, considered high by one speaker, was taken from a paper by Esso Research and Mr Wilford thought it showed the very good thermal efficiency of the diesel engine.

Investigations on transmission losses in fluid couplings, as used on the buses, were in progress and might lead to fuel savings.

In regard to the number of buses in use in off-peak hours, Mr Wilford stated that many of these were running with light loads to strategic points to be ready for rush-hour traffic. Such movements were inevitable because London Transport had only one bus garage in the inner area of London.

The improvement in fuel consumption noted with a rise in ambient temperature was largely caused by lowering of the viscosity of the lubricating oil and the reduction of engine friction losses.

It was suggested that during the peak hours only alternate bus stops should be used. This meant, Mr Wilford replied, that some passengers would have to walk at least ¼ mile to a stop. It was also difficult to devise a method of advising the public which stops were to be used. By running past stops more would be lost in goodwill than was gained by fuel savings.

Replying to a question on refresher courses for drivers, Mr Wilford stated that all drivers first passed through a comprehensive school, traffic circulars were issued stressing the need for fuel economy, and qualified inspectors were on the routes to point out driving faults likely to increase fuel consumption.

With regard to siting stops close to traffic lights, which accounted for 16 per cent of total stops in the central area, so that one halt sufficed for both purposes, Mr Wilford regretted that this was not possible. The Metropolitan police stipulated that stops should not be within 40 ft of traffic lights, on grounds of pedestrian and passenger safety.

In order to increase flexibility of operation and reduce bunching of buses the Operating Department by means of its bus-running control had made enormous efforts and during the past two years, despite greater traffic congestion, had improved bus-operating efficiency.

On the question of utilization of air-cooled diesels, Mr Wilford mentioned operation of air-cooled petrol-engined buses many years ago. Tests were abandoned because of excess heat in the driver's cab and increased noise. A further disadvantage, in view of current demands for more comfort, was the increased difficulties of heating passenger accommodation when an air-cooled engine was employed.

A speaker pointed out that if the 2s 6d tax per gallon of fuel was removed fuel costs would then become only 4½ per cent of operating costs, and asked whether London Transport would still be interested in obtaining maximum economy. Mr Wilford answered in the affirmative and added that in 1925, when petrol engines were in use and before a fuel tax was imposed, much work was done on standardizing carburettor settings. For the first time exhaust gas analysis was seriously introduced on London Transport and settings, determined on the results of such analysis, saved at the time £70,000 a year. To-day traffic congestion cost London Transport an additional £40,000 a year in fuel tax.

Asked why so many buses were used in the central area, Mr Wilford replied that the passengers could not be moved by other means. There were insufficient underground railway routes.

With regard to fuel savings from use of 5 W lubricating oil, London Transport had made long-term tests. These showed, in comparison with a 30 W oil, there was no improvement gained by

using a 5 W instead of a 10 W. The engineers preferred the thicker oil as a safety margin. 5 W oil, however, might be more economical where routes were easier.

Asked if comparisons were available of the effect on fuel consumption between worm and bevel-drive axles, Mr Wilford stated that London Transport had experience only of the worm-driven axle. This was on the way out because the RM-type bus would have a spiral-bevel drive. Present methods of improving fuel consumption were confined to altering the oil in the worm-driven axle which would continue in use for the next 10 years or so.

On the question of weight saving, and taking into account fuel costs and wear of tyres and brakes, the reduction of 1 lb in the weight of a bus would save 12s 3d per annum over a period of 17½ years, which was the average life of a bus.

Excessive wear from frequent cold starts was not encountered on the majority of the buses since engines had no chance to get cold on stands. On what was termed the "spread-over buses" which did perhaps a few journeys in the morning and a few at night fuel consumption was excessive because of the warming-up needed and because these buses encountered the worst of the traffic.

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World Oil Industry in 1957

The *Statistical Review of the World Oil Industry* 1957 has recently been published by the British Petroleum Co. Ltd. The information given below is taken from the brief commentary that introduces the survey and is supplemented by data extracted from some of the tables that are included in the book.

Reserves

World reserves continued to grow at a faster rate than production and the largest expansion again took place in the Middle East, where reserves rose from 19,270 million tons in 1956 to 22,665 million tons in 1957. In the U.S.A., for the first time since 1943, reserves showed a small decrease, from a total of 4720 million tons of oil and natural gas liquids in 1956 to 4680 million tons in 1957. Details are given in Table I.

Production

The rate of increase in world crude oil production outside the U.S.S.R., etc., at 4 per cent, was half the average rate over the past ten years. In the first half of the year Middle East production was reduced as a result of the cutting of transport facilities. In the second half-year the stagnation of demand in North America led to a reduction in U.S. and Canadian production.

TABLE I

World "Published Proved" Oil Reserves as at End 1957 *and* 1956

(million tons)

Western Hemisphere	1957	1956	*Eastern Hemisphere*	1957	1956
U.S.A.			MIDDLE EAST:		
Crude oil	4,020	4,040	Iran	4,295	4,025
Natural gas liquids	660	680	Iraq	3,300	2,900
			Kuwait	8,100	6,750
	4,680	4,720	Neutral Zone ...	710	90
			Qatar	200	195
CARIBBEAN:			Saudi Arabia ...	5,935	5,275
Venezuela ...	2,255	1,860	Southern Arabia ...	65	—
Colombia	90	90	Other Middle East	60	35
Trinidad	45	40			
			Total	22,665	19,270
	2,390	1,990			
CANADA	430	410	AFRICA	110	40
MEXICO	380	350	WESTERN EUROPE ...	190	195
ARGENTINA	105	60	EAST INDIES ...	1,075	745
PERU	35	35	OTHER FAR EAST ...	65	65
OTHERS	35	20	U.S.S.R., ETC. ...	3,545	3,350
TOTAL W. HEMISPHERE ...	8,055	7,585	TOTAL E. HEMISPHERE ...	27,650	23,665

World totals: 1957, 35,705; 1956, 31,250.

Consumption

Due to the supply shortage induced by the Suez crisis and to the slackening of world industrial activity—particularly in the U.S.A.—demand for oil products was only some 4 per cent higher than in 1956. Of the world total of 883 million tons, the U.S.A., with a figure of 425 million tons, accounted for 48 per cent of world consumption. Russia's share showed an increase of 14 per cent over that for 1956, and was 105 million tons for the year. Every area considered in Table II shows an increase in 1957, the rate of increase varying from 3 per cent in Africa to 15 per cent in the far East.

Supply and Demand

The distortion of oil supply caused by the Suez crisis was removed by mid-year, although availability at the Eastern

TABLE II

World Oil Consumption 1957 *and* 1956

(Crude oil equivalent)

	1957 *Million tons*	1956 *Million tons*	*Change* 1957 *over* 1956 (*per cent*)	*Change* *Average* 1952 *to* 1957 (*per cent*)	1957 *share of total* (*per cent*)
U.S.A.	425	425	Nil	+ 4	48
Canada	39	36	+ 8	+11	4
Mexico	13	12	+ 8	+ 8	2
Caribbean ...	18	17	+11	+ 5	2
Other West ...	45	41	+10	+ 8	5
TOTAL W. Hemisphere	540	531	+ 2	+ 5	61
Western Europe ...	136	136	Nil	+11	15
Africa	28	27	+ 3	+ 9	3
Middle East ...	19	17	+12	+12	2
East Indies ...	6	5	+12	+ 9	1
Australasia ...	11	10	+10	+ 8	1
Other East ...	38*	33	+15	+11	5
Eastern Hemisphere, excl. U.S.S.R., etc. ...	238	228	+ 4	+10	27
U.S.S.R., etc. ...	105	92	+14	+15	12
TOTAL E. Hemisphere	343	320	+ 7	+11	39
WORLD, excl. U.S.S.R., etc. ...	778	759	+ 3	+ 6	88
WORLD	883	851	+ 4	+ 7	100

*Includes unascertainable stock change.

Mediterranean terminals was not back to normal by the end of the year. The year ended with a world rise in stock of 16 million tons.

Refining

World refining capacity increased by some 5 per cent during the year. The major expansions were in Canada, Venezuela, Australia, and Japan. At the end of 1957 total world capacity was 951·9 million tons per annum compared with 904·7 million tons in 1956. Of this total the Western Hemisphere accounted for 611·9 million tons and the Eastern Hemisphere for 340·0 million tons.

Tanker Fleet

The world tanker fleet showed an increase of 5 million dw tons over 1956, which represents a rise of 12 per cent. Of the world total of 49.6 million tons, oil companies owned 17·9 million tons. British owners represented 17 per cent of world ownership but this percentage was also attained by Liberia. The strong demand for shipping in the early part of the year fell off rapidly and by the end of 1957 a considerable number of vessels were laid up. At the end of 1957 32·9 million tons dw of tankers were under construction or on order, and of this, 13·3 million tons were for vessels in the 30,000–45,000 ton range, 9·5 million tons for ships in the range 45,000–65,000 tons, and 1·9 million tons in the range exceeding 65,000 dw tons.

INCREASE IN U.K. CONSUMPTION OF PETROLEUM PRODUCTS IN FIRST QUARTER

Deliveries, excluding bunkers, of petroleum products for inland consumption in the United Kingdom during the first quarter of 1958 showed a substantial increase over those for the corresponding quarter of 1957 when petrol rationing and fuel restrictions were in force. The increase was 2,111,941 tons, according to figures published by the Petroleum Information Bureau on behalf of the U.K. Petroleum Industry Advisory Committee. Rises occurred in each of the groups considered, with the exception of aviation fuels and bitumen. In the first quarter of 1958 there was a fall of 31,071 tons in deliveries of aviation fuels, and of 11,650 tons in the deliveries of bitumen. Full details are given in the table below.

U.K. Deliveries into Inland Consumption of Petroleum Products*

Product	*January to March*	
	1957	1958
	tons	*tons*
Aviation fuels	403,089	372,018
Motor spirit (incl. motor benzole):		
Premier grades	454,650	759,505
Standard grades	532,945	635,701
	987,595	1,395,206
Industrial spirits (incl. industrial benzole)	41,945	46,880
White spirit	36,563	37,034
Kerosine:		
Burning oil	269,191	464,004
Vaporizing oil	105,712	89,256
	374,903	553,260
Derv fuel	387,368	488,173
Gas, diesel, and fuel oils:		
Gas/diesel oil	524,841	834,016
Fuel oil	1,704,641	2,739,155
Refinery consumption ...	507,944	579,951
	2,737,427	4,153,122
Lubricating oils and greases ...	197,015	205,792
Paraffin wax and scale ...	12,639	13,889
Propane and butane	17,478	19,948
Bitumen	192,763	181,113
Other products	178,435	212,726
	5,567,220	7,679,161

*Excluding bunkers for ships engaged in the foreign trade.

SCOTLAND CONSUMPTION OF PETROLEUM PRODUCTS

Deliveries (excluding bunkers) of petroleum products for inland consumption in Scotland during the year ended 31 December 1957, despite 4½ months of fuel restrictions and rationing, showed an increase of 103,621 tons, according to figures published by the U.K. Petroleum Industry Advisory Committee.

There were increases in deliveries of industrial spirits, derv fuel, and gas, diesel, and fuel oils. The largest rise, however, occurred in the category of other products.

There was a sharp decline in deliveries of motor spirit, and smaller reductions in aviation fuels, kerosine, and lubricating oils and greases. Full details are given in the table below:

Scotland Deliveries into Inland Consumption of Petroleum Products*

Product	*January to December*	
	1956	1957
	tons	*tons*
Aviation fuels	172,153	139,834
Motor spirit (incl. motor benzole:		
Premier grades	248,832	237,158
Standard grades	264,255	229,454
	513,087	466,612
Industrial spirits (incl. industrial benzole)	22,098	34,409
White spirit	11,457	10,614
Kerosine:		
Burning oil	58,325	55,934
Vaporizing oil	65,367	57,417
	123,692	113,351
Derv fuel	207,033	208,851
Gas, diesel, and fuel oils:		
Gas/diesel oil	242,856	251,309
Fuel oil	457,764	512,157
Refinery consumption ...	187,605	218,484
	888,225	981,950
Lubricating oils and greases ...	76,521	72,337
Paraffin wax and scale ...	2,441	1,540
Petroleum gases...	9,785	9,277
Bitumen	158,955	151,239
Other products	112,269	221,323
	2,297,716	2,411,337

*Excluding bunkers for ships engaged in the foreign trade.

Analysis and Applied Physics at Sunbury

Extended Facilities at BP's Research Centre

The Sunbury Research Station of The British Petroleum Company Ltd was founded in 1917 by Dr A. E. Dunstan. It was then mainly concerned with analytical research. To-day its newest and largest building houses one of the finest functional laboratories in the United Kingdom.

Among the latest additions at the Sunbury Research Centre of The British Petroleum Company is a magnificent new building specially designed to house the staff and equipment of the Analytical Section and of the Applied Physics and Chemical Engineering Section. Previously these sections had been housed in various permanent and semi-permanent buildings located in various parts of the 19-acre site occupied by the Research Centre.

The new building, largest on the site, is unique in many features. First of these is its shape, which is triangular in plan with a centre triangular courtyard. The total area of the plot on which the building stands is 40,000 square feet and it was calculated that if the conventional E layout had been employed the total usage would have been 63½ per cent of the plot area. By using the triangular layout it was possible to utilize 78 per cent of the plot area. Consequently, the three floors and the three penthouses have a total enclosed area of 73,856 square feet.

Construction work was commenced on 25 June 1956, the day upon which a commemorative stone was laid by the late B. R. Jackson, then chairman of the Company. The work was completed on 31 December 1957, five months ahead of schedule. The building was in occupation and functioning within about two weeks of the completion date.

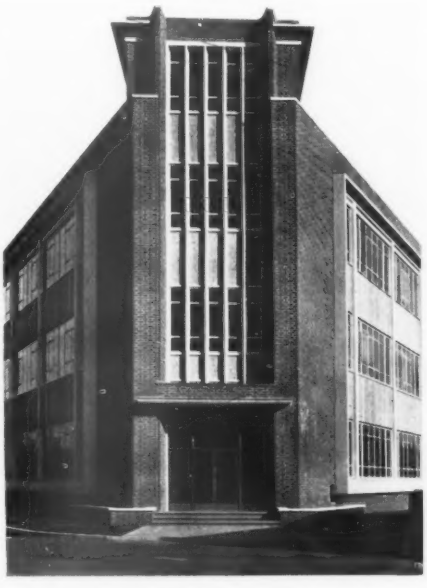
The main reason behind this achievement is another feature of this building. It was completely pre-planned in every detail prior to any work being started and no deviations were permitted after the detailed plans had been finally approved. The Company's consulting architect, in consultation with the contractors, was responsible for construction details and the internal design and layout was entirely the responsibility of the staff of the Research Centre itself.

In September 1955 the consulting architect submitted his sketch elevations and these were in due course approved. Meanwhile, those members of the Research Centre who were to occupy and administer the new building had been busy on their plans for the layout of space and equipment. The term equipment was interpreted in the widest sense and included not only laboratory equipment but the contents of every room in the building—it included such items as desks, chairs, clocks, and telephones. By 6 March 1956 the plans for every inch of space were completed and made up into one book from which, as mentioned above, no deviation was allowed. The result is what is probably the finest functional and analytical laboratory in the United Kingdom and a remarkable tribute to the value of careful thought and planning.

It is pertinent to note also that similar thought and planning was applied to the move of at least £200,000 worth of equipment when the new building was ready. Even though that date was five months before schedule, this had been anticipated and the move was completed in 15 days without undue delay to the work of the Sections concerned.

Some of the main features of the building are discussed in the following notes.

The main entrance to the building makes an imposing picture



Accommodation

The total number of rooms in the building is 155, made up of 113 laboratories, 24 offices, and 18 amenities. Included in the laboratories are 6 dark rooms and 22 balance rooms, the amenities consisting of sample-reception rooms, store rooms, toilets, and a kitchen for the preparation of morning and afternoon refreshment.

Ceiling height is generally 11 ft and the width of the corridor between the inner and outer rooms is 5 ft. Staircases in modern design and décor are located at each corner of the triangle and one passenger lift is provided. A goods lift with a capacity of one ton is also available.

The three penthouses on the roof house respectively the internal automatic telephone exchange for the whole site, and air-conditioning plant, and water tanks.

One corner of the new building covers an existing deep air-raid shelter. This has been retained and is at present used for document storage.

Services

In any laboratory it is essential that all services—water, power, heat, etc—should be readily accessible without a major operation. In this building maximum accessibility has been achieved.

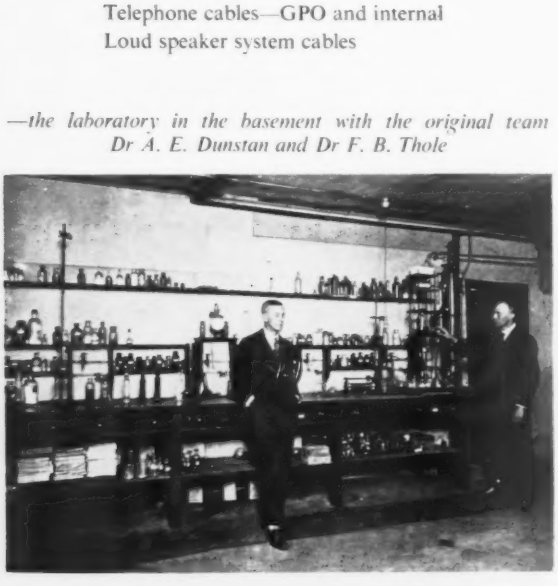
Meadhurst, *where B.P's first research station was established in* 1917, *and—*

All service mains are contained in a 6 ft by 6 ft duct which is continuous and central under the three sides just below surface level. These mains are carried on brackets attached to the walls or hung from the roof. Incidentally, so careful was the planning here that bolts in the concrete to which the brackets are attached were practically all in their exact position.

The services carried in this duct include:

AC supplies—110, 220, and 440 volts
DC supply—100 volt
DC battery emergency supply—100 volt
Steam
Hot water for radiators
Compressed air
Town gas
Water—town and well
Telephone cables—GPO and internal
Loud speaker system cables
Fire alarm system cables
Drainage—laboratory, soil, and storm.

—the laboratory in the basement with the original team Dr A. E. Dunstan and Dr F. B. Thole



Drainage from the roof is brought down inside the main stanchions through pitch-fibre pipes.

From the service duct, the mains are carried to all floors through vertical shafts in the corridor walls. At floor level the shafts are covered by red wall panels in contrast to the general grey wall colour. These panels are held in position by quick-release screws to facilitate access to valves and switches. Thus, in the case of an emergency, the supplies to any laboratory can be cut off from the outside.

Inside the laboratory these services are connected to the points at which they are required, the necessary valves, stopcocks, or switches being provided.

The 1958 *version. Just one of the many rooms devoted to analysis, physics, and chemistry. Note the hot plate* (bottom left) *which is flush with the bench top. Benches are of light oak with teak tops*

To provide maximum flexibility in take-off positions, all service lines are provided with T-junctions at suitable intervals behind removable panels.

Bottled Gases

The only supply service not located in the main duct is that for bottled gases—nitrogen and oxygen. For these gases the bottles are kept outside the building in the centre courtyard and are separated from the building by blast-proof walls. Each of these shelters is provided with valves, pressure gauges, and feed lines connected to the laboratories in which such gases are required. Take-off points in the laboratories are fitted with valves and pressure gauges also.

Balance Rooms

Bearing in mind that there is no such thing as a perfect balance bench for all purposes, but that each bench needs to be designed to meet prevailing conditions, particular attention was paid to the design of the benches used to support the balances in the various laboratories.

The basis of each bench is two or more pillars of glazed brick. These pillars are surmounted by several layers of thick felt separated by cork layers and containing a ball-bearing device to prevent any lateral vibration reaching the balance.

On top of these is a heavy asbestos-cement base-plate on which sits the balance in its case.

Surrounding the base-plate and isolated from it by a small gap is a wooden "leaning board", which is fixed to the wall and supported by tubular legs in front. As the name implies, this board enables the operator to rest his arms while making a weighing and also serves as a convenient place on which to place equipment without affecting the equilibrium of the balance.

Timing Device

A notable feature in these laboratories is the apparent absence of stopwatches, stopclocks, or other timing devices. All timing is from a central master timer of the quartz crystal type giving $\frac{1}{5}$-second impulses. From this central instrument wires connect to points where timed-tests are carried out. When a timing is required a counting device is plugged in and started by a push-button. Stopped by a push-button when the test is complete, this device records the time accurately to better than $\frac{1}{5}$ second in one hour.

Fume Cupboards

Here again careful consideration has been given to design to secure maximum efficiency with minimum effort. No longer is it necessary to lift a heavy sash window to place apparatus in the fume cupboard; no longer is it necessary to reach to the back of the cupboard for some service supply.

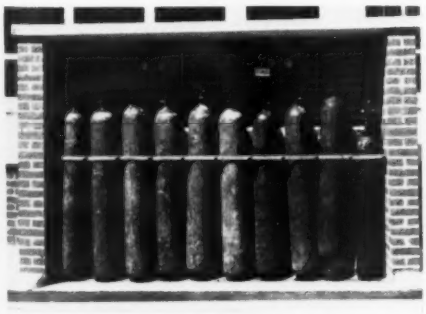
In the fume cupboards in the new building air is supplied to each hood as a "curtain" to prevent fumes entering the room and is also supplied through the base of the cupboard. This provides an adequate flow of air to remove all fumes and at the same time ensures the minimum removal of warm air from the rest of the laboratory.

The services—gas, electricity, air, water—are fed in from the front of the cupboard and all controls are on the front board under the sill.

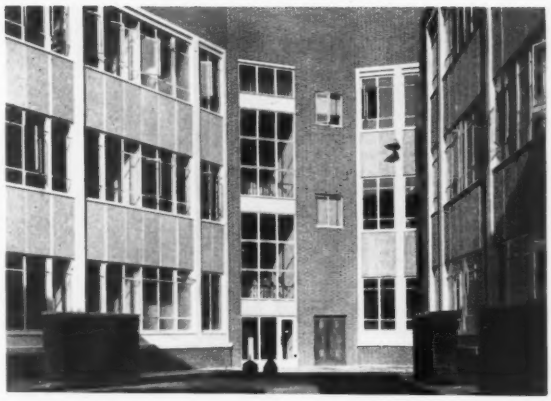
Lighting

All lighting in laboratories and corridors is by overhead fluorescent tube. In the laboratories the lighting is patterned on to benches and in general every bench has a light intensity of 30 foot-candles.

Ceilings throughout are panelled. Consequently, if it is desired to re-position a light, it is only necessary to change over a light panel and a ceiling panel. Office lighting is by conventional filament lamps.



Detail of the bottled gas supply system



The centre courtyard. Three bottled gas supply points are shown

Safety Precautions

Special attention has been paid to safety and fire precautions. Thus, every occupied room has at least two doors and in the laboratories one of these is on the window-side of the room. This ensures that in an emergency personnel can move to safety without the necessity of having to use a corridor.

In order to minimize draught in case of fire, every corridor has doors at each end. Normally, these doors are kept wide open to permit free passage but, in an emergency, are immediately closed.

Wet and dry rising mains are fitted in every corridor. The wet risers are coupled direct to reeled hoses which can rapidly be brought into operation. Every laboratory has its supply of small CO_2 extinguishers.

General Facilities

The building is heated throughout by hot-water radiators. Air-conditioning is by the admission of "tempered air" to provide four or five complete changes per hour.

All laboratory benches are of wooden construction, some being covered with plastic and others having teak tops. In some cases, desks or writing facilities are an integral part of the bench. In others, the desk is a separate piece of furniture located in the most suitable position.

Waste-oil sinks are available in most of the laboratories, these being directly connected to sumps at ground level in the courtyard. These sumps are emptied by means of portable pumps at regular intervals or when necessary.

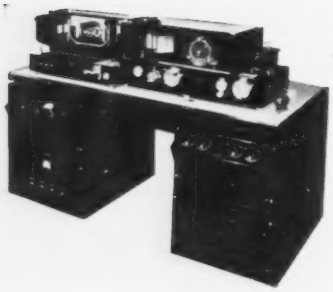
Where corrosive products or materials are handled the sinks are constructed of stainless steel or lead.

A comfortable and well-appointed Conference Room is available for technical discussions.

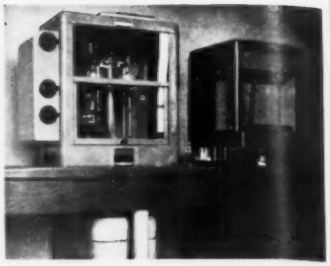
Cleanliness is essential in any place where research and analytical investigations are performed. For this purpose, a full-time staff of fifteen are employed with a part-time staff of twelve.

THE ANALYTICAL SECTION

The Analytical Section of The Sunbury Research Centre, under the direction of W. H. Thomas, A.R.S.M., F.R.I.C., F.Inst.Pet., operates in two main spheres—Analytical



Among the apparatus available is this Grubb-Parsons double-beam infra-red spectrometer



Balance benches are supported on solid brick pillars and the "leaning board" is independently supported

Research, which is the responsibility of H. Powell, Ph.D., F.Inst. Pet., and Analytical Services, which are the concern of J. H. Parkinson, M.Sc., F.Inst.Pet. There are eleven operational sub-sections:

Crude oil assay;
Gas analysis;
Light oils;
Lubricating oils;
Fuel oils;
Insecticides;
Specialities;
Production inspection;
General analysis;
Analytical investigations;
Spectroscopy.

and two general sub-sections:

Laboratory services;
Special duties.

Total staff at present number 133, of which 119 are engaged on actual technical investigations, and these are housed in two sides of the new building.

In walking through these laboratories one is particularly struck by the very wide variety of apparatus used in the examination and testing of crude oil and its products. Apart from that conforming to IP or ASTM standards, there is hardly a laboratory which does not contain some piece of specially-designed apparatus. Much of this special equipment has been designed and fabricated in the Research Centre. It is, for example, fascinating to watch the glass-blower producing most fantastic shapes in glass.

Among some of the most interesting examples of the work of the Analytical Section are the apparatus and techniques designed for the micro-analysis of crude oils. For a straight distillation test a sample of 1 millilitre is ample and for a complete fractionation and analysis only about 5ml of sample is required. This provides a valuable tool in connexion with geological work as it enables type analyses to be made on the very small quantities of oil which may be extracted from core samples.

In the field of spectroscopy the Section is well equipped, having two mass spectrometers (MS2 and MS3 types), two infra-red and two ultra-violet instruments, and two emission spectrometers. One of the latter is a Hilger direct-reading type and can deal with up to eleven elements.

Other pieces of special apparatus designed at Sunbury include an instrument for determining the presence of carbon in used lubricating oil by measuring the absorption of light of a sample in a standard cell. Also, there was seen an instrument for the automatic titration of the acidity of an oil.

A considerable amount of experimental work on the X-ray method of determining sulphur in petroleum was carried out at Sunbury. The prototype apparatus, a Sunbury design, is still in use there.

Throughout the analytical laboratories every endeavour has been made to maintain interest in the work and to avoid boredom. Wherever possible menial tasks are mechanized—for example the hand-operated pestle and mortar has been replaced by a machine-operated version which can be left to do the job on its own. Where standard or other tests have to be carried out on a routine basis, for example, in the Product Inspection Laboratory where all marketed products are examined, there are batteries of equipment for each test. Thus, for sulphur determination, extraction tests, carbon residue, etc., one operator can control a number of individual tests with little effort.

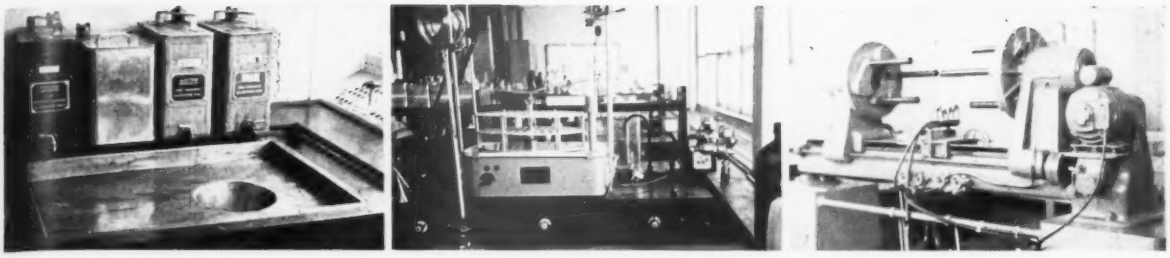
APPLIED PHYSICS AND CHEMICAL ENGINEERING SECTION

This section is under the control of K. G. Brummage, D.Sc., Ph.D., A.Inst.P., and second in command is R. W. Cranston, B.Sc., A.Inst.P., A.F.Inst.Pet. The main functions of the Section are the study of the rheological properties of oils; chemical engineering aspects of refining processes and product utilization; the development of instruments; mathematics and statistics; combustion research; and corrosion problems.

The total staff is 57 of whom 36 are graduates and these include physicists, chemical engineers, electronic engineers, mathematicians, and statisticians. As in Analytical Section, in a tour of this part of the Sunbury organization, which is housed mainly in one of the three sides of the new building, one is impressed with the evidence of technical ability and the thoroughness of investigation.

In the field of rheological properties the accent is on the pumpability of heavy fuel oils. Through the Group dealing with this subject, Sunbury has taken a leading part in the work of the Panels of the Admiralty Fuels and Lubricants Advisory Committee dealing with fuel oil pumpability, and has participated in a large amount of field work on the flow of oil in pipes. This work has resulted in a considerable amount of practical experience which is of great value in the design of pipelines for non-Newtonian liquids.

On the chemical engineering side, the investigations are carried out by chemical engineers and by chemists, the stress being on the use of chemical engineering techniques in the solution of a variety of problems. Thus, the subjects under investigation include the properties of jet fuels in relation to the design of supersonic aircraft, and in the field of petroleum refining, such matters as the coking of heaters in lubricating



Some of the very modern equipment with which the Sunbury laboratories are equipped. (Left) *Stainless-steel oil sinks, connected direct to separators below ground level, simplify the removal of waste oil.* (Centre) *A fraction collector which automatically takes 100 samples at regular predetermined intervals.* (Right) *Sunbury is noted for the intricate glass equipment which it can fabricate. This glass lathe facilitates that work*

oil refining plants and the study of flow patterns in flash stills.

For the development of instruments, the work of the section is divided into two main types. The first type is covered by a Group for the development of electronic prototype instruments, mainly for use in research work at Sunbury. The second Group deals with instruments which are in general non-electronic in nature. These include apparatus for gas chromatography, thermal diffusion, and so on.

The mathematical and statistical Group provides a service to the Research Centre as a whole. It advises other Sections in regard to mathematical work and acts as a liaison with the Company's head office in London, where a Deuce computer is available; members of the Group are trained in the programming of problems for the computer. Calculations can be teleprinted to Deuce in London and the results of the computations can be received at Sunbury by the same medium. On the statistical side, this Group provides a service for the statistical analysis required to assess the accuracy of test results. It also undertakes and advises on the statistical planning of experimental programmes, and disseminates information on statistical methods at Sunbury and at other BP centres.

Combustion research as such is not carried out in the new building, but various types of equipment are housed in other buildings. Work is being done on fuel and corrosion problems in relation to continuous combustion in boilers, and also on air pollution. High-temperature corrosion in gas turbines burning residual fuels is being investigated, and low-temperature corrosion in boilers and allied equipment is also a subject under study.

Corrosion testing is an important part of the work of the Section, and facilities are available for studying the microstructure of materials used in engineering and corrosion investigations. There is a close contact with the BP Tanker Co. on corrosion prevention in tankers by cathodic protection and other means.

A considerable amount of work is done on jet fuels, including filtration to remove solid materials and also the separation of water. A large number of filter materials has been examined and for this purpose it is the practice to introduce into the fuel materials which have a particle size as low as 5 microns or less. These substances are usually zinc or glass spheres. The filter materials have included paper, nylon, and sintered metal, and they are tested both for filtration efficiency and for their resistance to the flow of fuel. A rig in another building tests complete filter units and also water separators for use at airfields.

The Applied Physics Section is also responsible for the standardization and testing of a large amount of routine equipment purchased not only for the Research Station itself but for laboratories at other BP centres. Equipment is available for the calibration of viscometers, thermometers, and similar instruments. Other apparatus is used for dimensional checking of equipment for conformity with IP, ASTM, or Company standards.

The staircase is an indication of the modern décor of the building

IRANIAN INSTITUTE OF PETROLEUM

During the Summer Meeting of the IP the President announced that there had recently been established an Iranian Institute of Petroleum. He proposed and the proposal was agreed that the following message should be sent to the new Institute: "The members of the Institute of Petroleum in session at their Summer Meeting learn with pleasure that a sister body, to be known as the Iranian Institute of Petroleum, is about to be inaugurated in Teheran. The Institute of Petroleum sends greetings and good wishes and it looks forward to many years of fruitful collaboration".

COMPOSITION OF IP COUNCIL

Members will have noticed that the list of membership of the IP Council, as given on the inside cover of the *Journal*, no longer includes all the past-presidents. The reason for this is that, under the new Articles of Association and By-laws approved at the Annual General Meeting in April, only the immediate past-president (at present Lord Geddes) remains a Member of Council. Sir Stephen Gibson, who is a past-president, is included as an ordinary Member of Council because he has been nominated by Council as an Additional Member of Council in accordance with Article 30(E).

*Test Results on Submarine Tankers**

By **W. A. CRAGO**†

The article in the September issue of *Impulse* on the testing of submarine-tanker models appears to have attracted world-wide attention. At that stage only general observations could be made on the project initiated by Mitchell Engineering Ltd. But the idea of constructing huge submarines of perhaps 100,000 tons weight, driven at high speeds by nuclear-powered engines, has clearly caught the public imagination and stimulated considerable commercial interest. The tests were carried out in the experimental tanks of Saunders-Roe Ltd at Cowes. It is now possible to assess the results of the test data obtained and, as indicated in my first article, to discuss certain of their implications.

Model Characteristics

For the tests six models were made from laminated mahogany. To these an impervious white surface finish was applied which was then reduced to extreme smoothness by means of fine abrasives. This was required in order that conditions within the boundary layer could be standardized and observed as will be described later (Fig 3.)

The physical characteristics of the models are given in the table below and their overall accuracy is believed to be such that their contours did not deviate from the design values by more than ± 0·01 inch.

Model No.	1	2	3	4	5	6
L	6	6	6	6	6	6
L B	7	10	14	10	10	11·3
Section shape ...	○	○	○	○	□	□
a L: per cent ...	40	40	40	50	60	40

The symbols employed are as follows:—

L is the length of body in feet; a is the distance aft of the nose of the maximum cross-section in feet; B is the maximum beam in feet.

Components of Resistance

As was made clear in the previous article, relatively little information is available about the resistance of submerged bodies. Thus the preliminary tank tests discussed here were necessary to investigate certain fundamental features of the hydrodynamic characteristics and to provide data upon which a design study of the final project could be made. To appreciate fully the implications of the work it is necessary to consider the major elements which together constitute the total resistance of an immersed body.

In a boundless fluid the total resistance is derived mainly from two components, these being respectively the pressure resistance and the skin friction. The first is the aft-facing component of the resultant force obtained by integrating the normal pressures all over the surface of the body. The second arises from the viscous nature of the fluid, and is the aft-facing component of the resultant force obtained by integrating the viscous tractions all over the surface of the body.

The introduction of a free surface adds a further complication, since as the body approaches this surface waves will be created and these will be associated with a change in pressure distribution and a resultant change in resistance. In fact, the closer the proximity of the surface, the larger both the surface waves and the resistance become.

Yet a further complication is presented by the finite depth of the sea. In effect, this results in a change of the potential flow over the body for any given speed and hence involves a change in skin friction. In addition, however, it also modifies the speed at which waves can be propagated so that the resistance associated with wave-making is also affected.

Whilst the influence of this latter factor on the resistance of surface vessels has been studied, no precise and universally applicable method of predicting its effect has been derived.

Fig 1
Coloured fluid bleeding into the boundary layer shows that a fully turbulent condition of flow, as described in the text, has been achieved by the use of the turbulence wire seen as a thin line across the bows of the model

*Reproduced by permission from the March 1958 issue of *Impulse*.

†Tank superintendent, Saunders-Roe Ltd, in charge of hydrodynamic testing.

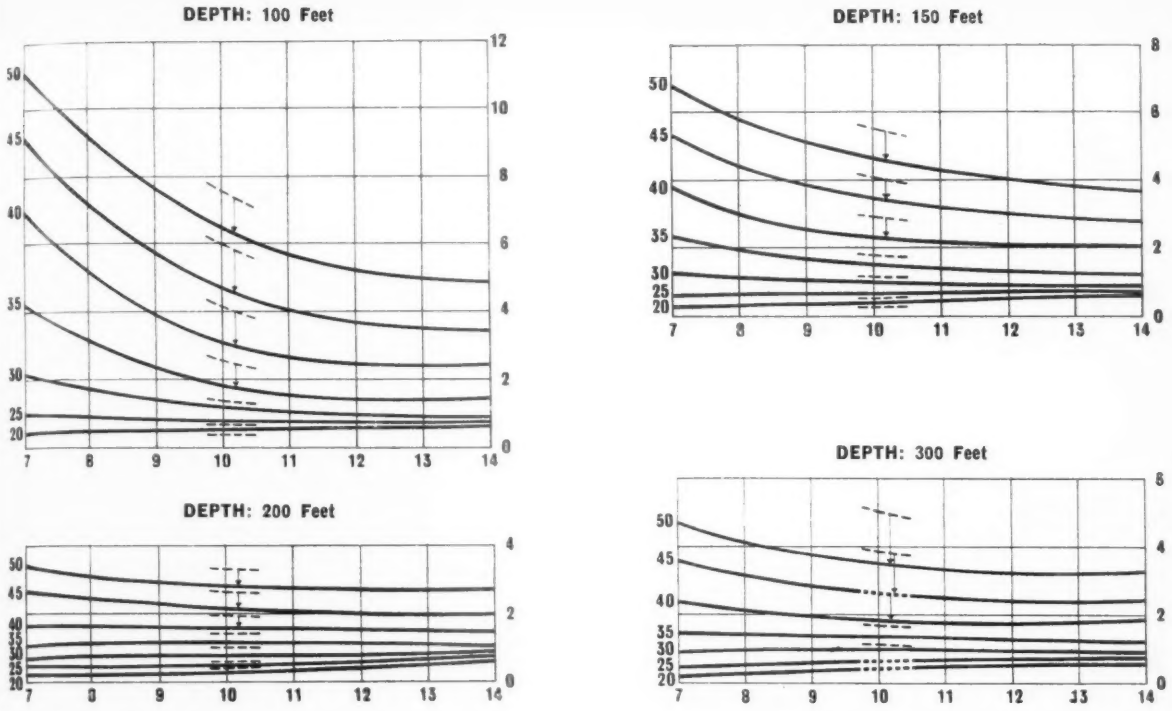


Fig 2. The effect of surface proximity is clearly demonstrated in these curves. It is of interest to see how the relative importance of L/B ratio is diminished as submergence is increased. It will be noted that the square-section tanker appears to have a slight advantage under some conditions, but in fact this is considered doubtful, since the value of the L/B plotted for this model is based on geometric features. Legend: Position of maximum diameter in model: 40 per cent length from nose. Vertical co-ordinates; total resistance in deep water, lb × 10^6. Horizontal co-ordinates: length: beam ratio, L/B. Speed in knots given for each graph line. Broken line: square section tanker

Physical parameters of models; the three below represent decreasing L/B. In the group on the right, the top two models represent maximum section moving aft. The bottom model is of square-section tanker

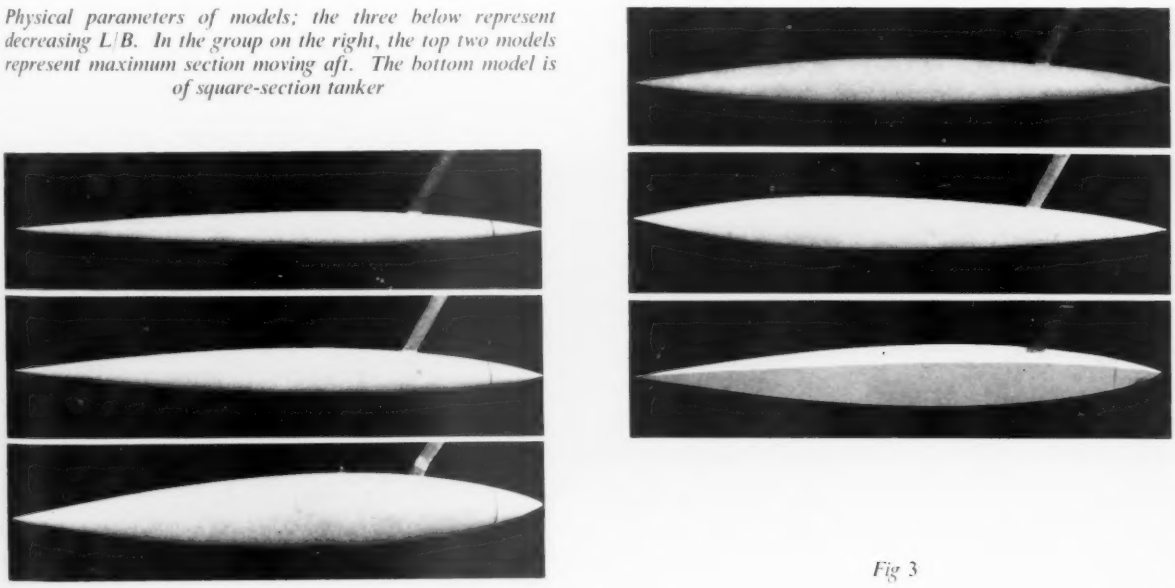


Fig 3

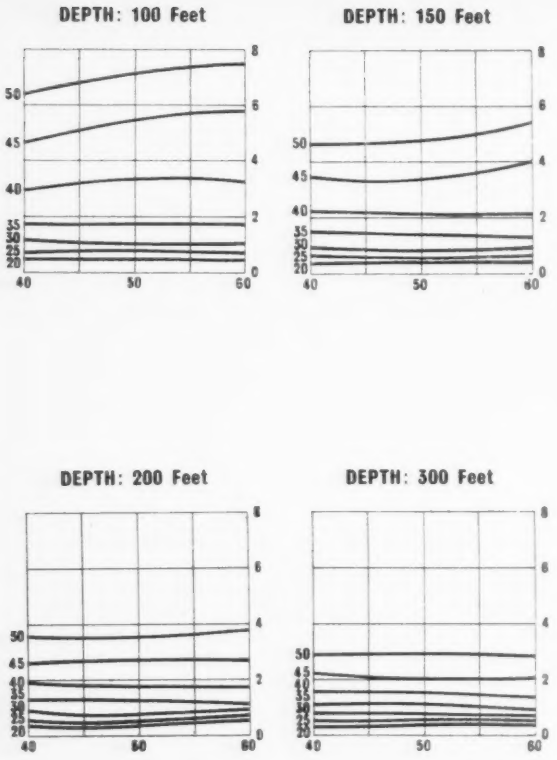


Fig 4

As in the case of Fig 2, *the influence of submergence is illustrated by the reduction of resistance at high speed with increase of immersion depth. The relatively small changes in characteristics associated with position of maximum thickness when at considerable depth are also of interest. Legend: L/B:* 10 *in each case. Vertical co-ordinates: total resistance in deep water, lb* $\times 10^6$. *Horizontal co-ordinates: position of maximum diameter as percentage of length from nose. Speed in knots given for each graph line*

Such data on totally submerged bodies are very scarce, and in order that an assessment of the accuracy of the available methods of allowing for shallow water effect could be made in the case of the submerged bodies, tests were carried out in both deep and relatively shallow water.

Conditions of Flow

The basic method of experimental study was to run the submerged model under predetermined conditions of draught and speed and to measure the resistance force. However, fundamental to the validity of the model-testing technique is the stimulation of a known and repeatable condition of flow within the boundary layer of the model. This is because differences in resistance are associated with the alternative types of boundary layer flow, and it will be appreciated that in the extrapolation of the model data to the full-scale regime it is vital to ensure that the component of force which can be attributed to viscous flow in the boundary layer is known exactly.

With these considerations in view it was thought advisable to monitor continuously the conditions within the boundary layer on the tanker models, and for this purpose a coloured fluid was allowed to bleed through small orifices set in the surface of the body. In this way visual observations of the flow provided definite evidence of the effectiveness of the type of turbulence stimulator chosen. At lower speeds the removal of the stimulation caused an immediate reversion to the laminar condition as confirmed by a characteristic and marked change in the pattern of flow. Similarly, the natural transition from the laminar to the turbulent condition in the absence of a stimulator was plainly evident at the upper end of the tested speed range. These differences in the flow are brought out clearly in Figs 1 and 5.

Analysis of the Tests

Each model was considered to represent a full-scale tanker having a displacement of 80,000 tons, and on this basis Figs 2 and 4 have been prepared from the test data to show how the resistance of such a craft varies according to immersion depth, shape, and speed. Whilst the curves are of considerable interest from a hydrodynamic point of view, detailed comment on them is out of place here. However, the following major conclusions may be drawn.

There is no single optimum shape for all conditions. The actual shape chosen for the full-scale craft could be selected from the test data obtained and would depend on the proposed depth of immersion, size, and operational speed.

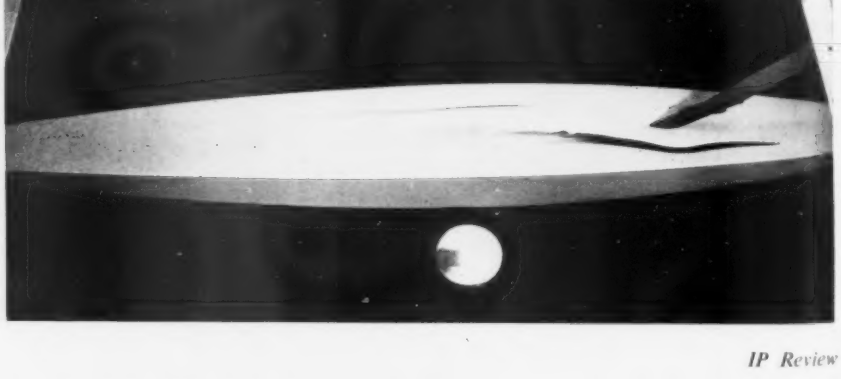


Fig 5

In contrast to Fig 1, *this illustration shows how the absence of a turbulence stimulator results in a laminar flow condition over the forward portion of the model and thus gives rise to a condition unsuitable for extrapolation to the full-scale régime*

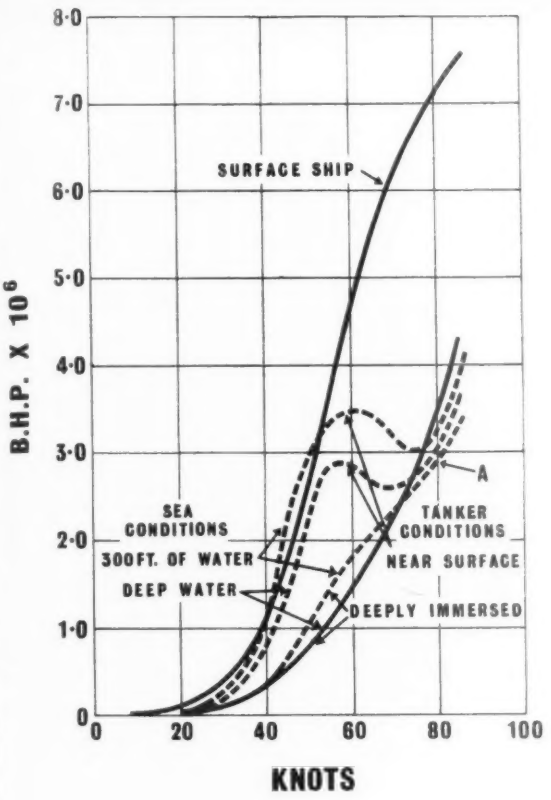


Fig 6. The curves show the outstanding advantage of a submarine craft if high speeds are contemplated

Fig 6 shows how the power required for an 80,000-ton tanker having an L/B of 10 depends not only on depth of immersion but also on depth of water available. Thus, above a speed of 58 knots in 300 ft of water (which is the so-called critical speed at this depth) the resistance falls off considerably and becomes less even than the values obtained in deep water. Hence the depth of water available over the proposed route for the craft would also have an influence on the determination of optimum shape. Of course the idea of travelling at 80 knots and of using such a tremendous horsepower is not practicable. But the curves can be scaled down to smaller displacements with no loss of validity and the point marked "A" corresponds also, for example, to a 20,000-ton tanker moving at 63 knots and demanding about $5{\cdot}9 \times 10^5$ brake horse-power in water 200 ft deep.

Of the implications of the test results which can usefully be considered here, perhaps the most outstanding feature is the comparison, shown in Fig 6, between a surface ship and the unorthodox tanker. But one thing is quite clear already. If in general transport speeds of 50 knots and upwards are required, the underwater tanker offers very considerable promise and merits close investigation of the engineering problems involved.

OIL COMPANIES' EQUIPMENT ORDERS IN FIRST QUARTER

Figures compiled by the Oil Companies Materials Secretariat, and issued by the CBMPE, show that during the first quarter of 1958 orders for materials and equipment placed in the U.K. by oil companies were valued at £32,526,199. This is a decrease of £3,522,504 compared with the total for the first quarter of 1957. There was a very large reduction in orders of geophysical and other exploratory equipment, amounting to some £39,000 compared with the first quarter of 1957. Decreases also occurred in the following groups: specialized equipment for drilling and production; drums, drumsheets, and tinplate; tubulars, pipe fittings, and valves; pumps; machine and hand tools; ferrous and non-ferrous plates, etc.; laboratory equipment and chemicals; and cement and bulding materials. There was a considerable increase in specialized equipment for refineries and increases in electrical equipment, automotive equipment, and bulk chemicals. Full details are given in the table below.

Total figures for the 12 months of 1957 are £134, 050,283, and for 1956 £153,730, 621.

	1957 *Jan.–March*	1958 *Jan.–March*
	£	£
Geophysical and other exploratory equipment, etc.	54,414	15,241
Specialized equipment for oil drilling and production, including oil casing, tubing, etc.	5,329,341	3,509,942
Specialized equipment for oil refineries, etc. (not including pumps and valves)	1,488,798	3,291,172
Drums and can-making, filling and cleaning equipment, kerbside pumps, and other metering and dispensing equipment, etc. ...	154,309	274,293
Railcars, road tankers, aircraft refuellers, etc.	52,834	80,308
Drums, drumsheets, and tinplate ...	1,974,870	1,878,773
Tankage (including tank fittings) ...	643,483	672,528
Tubulars, pipe fittings, and valves (ferrous and non-ferrous)... ...	5,181,181	4,315,470
Pumps (excluding slush, oil well, and kerbside)	538,444	377,344
Boilers, boiler-house plant and accessories, etc.	105,653	122,733
Electrical equipment—motors, generators, transformers, etc.... ...	1,916,471	2,456,802
Instruments, meters, and gauges ...	358,293	385,712
Prime movers and compressors ...	669,265	719,345
Machine and hand tools, welding and miscellaneous machinery, and stores	3,701,142	2,421,153
Ferrous and non-ferrous plates, sections, sheets, and bars ...	3,214,687	1,376,045
Automotive equipment, all types ...	1,766,344	2,360,862
Laboratory equipment and chemicals, including hospital and medical supplies...	357,379	328,125
Bulk chemicals, catalysts, barytes, etc.	5,101,551	5,161,398
Cement and other building materials and hardware, including timber ...	1,813,367	865,466
Commissary, general requisites for office, warehouse, household, club, and sports, etc.	1,626,877	1,913,487
	£36,048,703	£32,526,199

Britain's New School of Chemical Engineering

Formal Opening of Manchester Building

The New Chemical Engineering Building of The Manchester College of Science and Technology was formally opened on 19 May by Sir Alexander Fleck, K.B.E., D.Sc., LL.D., F.R.S., chairman of Imperial Chemical Industries Ltd. This building promises, as Sir Hugh Beaver, K.B.E., M.I.C.E., M.I.Chem.E., president of the Institution of Chemical Engineers, said later during the proceedings, to be one of Europe's major sources of chemical engineers for many years.

Presiding at the opening ceremony was Councillor M.P. Pariser, chairman of the College Council, who expressed the thanks of the College to all those individuals and companies who had contributed so much to make the new building possible. He also paid special tributes to H. Fairhurst, M.A., A.R.I.B.A., the architect, and to Professor Frank Morton, head of the Department of Chemical Engineering, Fuel Technology, and Metallurgy. Both these, said Mr Pariser, had been the moving spirits in the design and rehabilitation of the building.

The main entrance hall has an air of spaciousness

The Chemical Engineering Building

The expansion of the Chemical Engineering Department was originally planned in 1954–55 to provide facilities which were not available in the then existing College buildings. In May 1956 the cotton mill which now houses the Department was purchased and plans were drawn up for its modernization and conversion in two phases.

The first phase, the conversion of basement, ground and first two floors to take the Chemical Engineering Department and the Strength of Materials Sections of The Mechanical Engineering school, was completed by October 1957. The second phase provided for the conversion of the upper floors into laboratories for the Departments of Industrial Biochemistry and of Textile Chemistry, and into large drawing offices for the teaching of engineering drawing. This phase was completed in January 1958, some six months ahead of schedule.

Total floor area of the basement and seven floors of the main building is about 120,000 square feet. Separated from the main building by the main staircase and lift shafts is a five storey block of some 32,000 square feet and this is occupied by lecture and seminar rooms.

Most of the basement of the main building is used for strength of materials and fatigue-testing laboratories, one portion about 40 by 100 feet being the bottom storey of the Chemical Engineering laboratory. On the ground floor three large sections of the floor of this laboratory have been removed to provide space for the erection of distillation columns, etc. Access to these columns is therefore possible at basement and ground-floor levels and also from a gallery about 10 feet above the ground floor.

On the first floor are located the design office, research laboratories, conference room, lecture rooms, library, and office facilities, for the Chemical Engineering Department. Similar facilities for the teaching of Metallurgy and of Fuel Technology are available on the second floor, and for Textile Chemistry and for Industrial Biochemistry on third and fourth floors respectively. Fifth floor accommodation is wholly occupied by excellent drawing offices and these will be used for the teaching of engineering drawing to all engineering departments of the College. Here about 300 students can be working at one time.

Services

Particular attention has been paid to the provision of services, especially ventilation. Four ducts, each 10 feet square, extend from the basement to the sixth floor. Through these ducts all electrical, steam, gas, and water supplies are brought to the various laboratories and ventilation piping is carried to the exhaust fans on the sixth floor.

Services to individual benches are carried along the ceiling of the floor beneath to the service boxes in the laboratories. Provision is made for services to the maximum number of benches which could be contained in any area. Where these services are not yet in use they are covered by a floor plate.

Lecture Rooms

One large lecture room, capable of seating 130 students, is located on the ground floor and is fully equipped with cinema and sound projectors and other visual aid equipment. There are fourteen other lecture rooms, their seating capacities varying from 20 to 60.

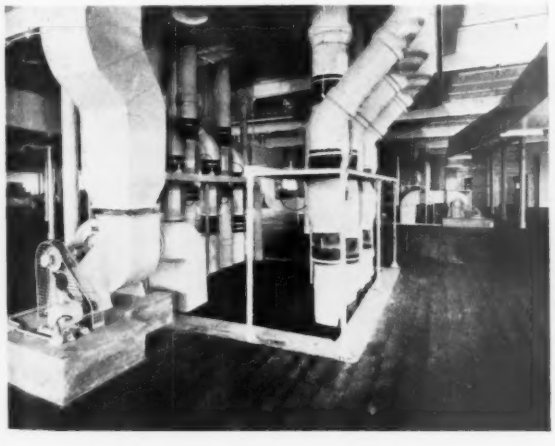
The Chemical Engineering Course

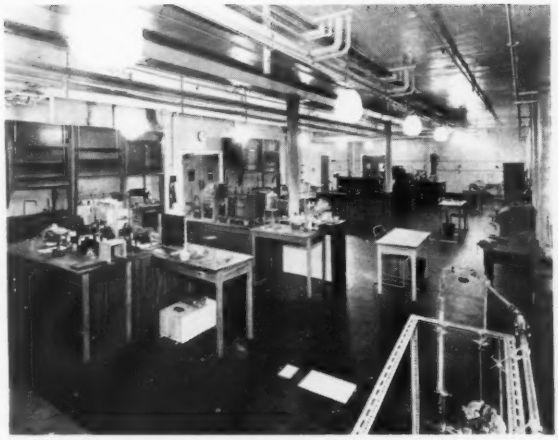
The first degree course in chemical engineering in the Faculty of Technology in Manchester was instituted in the 1933–4 session. It was included in the Department of Applied Chemistry and the first two years were the same as the general chemical technology course. The final year, to which only honours students were admitted, was devoted to chemical engineering subjects. The first graduate in chemical engineering graduated in 1935, having transferred from the general chemical technology course, and the first full 3-year course commenced in October 1934.

In spite of limited facilities available, a high standard of chemical engineering was established. However, the number of students permitted to take the course could not be great. In 1956 the new Department of Chemical Engineering, Fuel Technology, and Metallurgy was set up and Professor Frank Morton, M.Sc.(Tech.), Ph.D., D.Sc., F.R.I.C., F.Inst.Pet., M.I.Chem.E., was appointed first Professor of Chemical Engineering and head of the Department.

In the new school the syllabus has been completely rearranged in comparison with that of the previous course. Chemical engineering will be the main subject of each year of the 3-year course. Fundamental chemistry, mathematics, and engineering will be taught by the respective departments in co-ordination with the main syllabus. A close link with

Ventilation ducts and exhaust fans on the sixth floor





The corrosion research laboratory is a typical example of general laboratory layout

chemical industry in the area will be maintained and each student will spend two periods in industry. The first will be a long vacation course of six weeks at the end of the second year, and a three-week period during the spring term of the final year. The latter period will be spent in the study of an operating unit and the data thus obtained will be used by the student for a design study supervised by the University staff and the chemical engineers of the industry concerned.

A corresponding expansion in the research work of the school is also planned. In spite of the limited facilities previously available, the Department of Applied Chemistry had established a high tradition and this will be followed in the new school. An active research programme is being pursued, the studies including mass and heat transfer, liquid extraction, absorption, corrosion, and so on.

Facilities for the erection of tall distillation columns and similar plant are provided in the main chemical engineering laboratory

Personal Notes

J. R. Moore

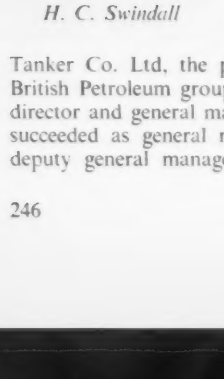
John R. Moore, A.M.Inst.Pet., who is currently chairman of the IP South-Eastern Branch following 4 years as secretary of the Branch, has been appointed director and divisional manager of the Fisher Governor Co. Ltd, Rochester, which is a subsidiary of the Elliott Automation Group of companies.

After practical training with Smiths of Cricklewood and with J. S. Moore & Sons Ltd, Mr Moore joined Swift and Swallow Ltd in 1941. He became chief planning engineer of that company in 1947. Shortly after the company's amalgamation with Elliott Brothers (London) Ltd, he was responsible, as production manager, for establishing a manufacturing unit for Fisher automatic control valves, which the Company was producing under licence.

Robert Gillespie, C.B.E., retired from the board of the British Petroleum Co. Ltd on 30 June, but remains on the boards of BP Tanker Co. Ltd and of BP Clyde Tanker Co. Ltd. **A. E. C. Drake,** C.B.E. has filled the vacancy on the board of the British Petroleum Co. Ltd.

W. D. Brown, M.Inst.Pet., has been appointed, from 1 July 1958, a director of BP Trading Ltd, the principal trading subsidiary of The British Petroleum Co. Ltd, to fill the vacancy created by the retirement of R. Gillespie. Mr Brown has hitherto been general manager, trade division.

In our last issue **L. T. Jordan,** C.B.E., was inadvertently described as joint manager of Kuwait Oil Company. He is, as is well known, general manager of the Company's operations in Kuwait.



H. C. Swindall

H. C. Swindall has been appointed general manager—finance and accounts, Shell-Mex and B.P. Ltd.

He joined the Company in March 1954 and in July of that year was appointed manager, marketing accounts department.

Mr Swindall qualified in 1938 and is a member of the Institute of Chartered Accountants of Scotland.

J. Houston Jackson has been appointed, from 1 July 1958, managing director of the BP Tanker Co. Ltd, the principal shipping subsidiary of the British Petroleum group. Mr Jackson has hitherto been a director and general manager of the BP Tanker Co. He is succeeded as general manager by **D. G. L. Bean,** hitherto deputy general manager.

National Benzole Co. Ltd announce that their managing director, **H. H. Bates,** is to retire on 30 September 1958.

He will be succeeded by **A. M. Robertson,** the Company's present general manager.

Mr Bates began his business career with Burt, Boulton and Haywood Ltd in 1923, and from 1924 to 1935 held appointments with this firm's associated companies in France and Germany.

In 1935 he returned to England and joined South Western Tar Distillers, Southampton, with whom he remained until 1951.

He became a director of the National Benzole Company in 1946 and in 1951 was appointed managing director. He became chairman of the Company in 1955, resigning from this office the following year but continuing as managing director.

Mr Bates remains chairman and managing director of Benzole Producers Ltd. He is also a director of Burt, Boulton and Haywood Ltd and of William Butler and Co. (Bristol) Ltd.

Mr Robertson joined the Anglo-Iranian Oil Co. (now British Petroleum Co.) in 1937, and was attached to their Paris office until 1939.

He rejoined the British Petroleum Co. in 1946 and until 1949 was at their head office in charge of marketing development in various overseas territories.

In 1949 he was seconded to British Petroleum's French associates in Paris as manager and subsequently assistant general manager. He returned to the head office of British Petroleum in 1953 as area manager for Germany, Switzerland, and Austria.

In 1954 he joined Shell-Mex and B.P. Ltd and was appointed general manager of Scottish Oils and Shell-Mex Ltd the following year.

He became general manager of the National Benzole Co. Ltd in 1957.

Photo by Jean Raeburn, N.Y.

E. F. Liebrecht

E. F. Liebrecht has been elected president of Kellogg International Corporation. Mr Liebrecht, who will continue as a vice-president of The M. W. Kellogg Company, will establish his office at Kellogg House, London. He was also elected president of Société Kellogg, and will be responsible for the direction of this company's activities in France.

Warren L. Smith, president of The M. W. Kellogg Company, stated that the election of Mr Liebrecht to these positions, and the location of his office in London, show the increasing importance and growth of the Company's services in the U.K., Europe, Australia, the Middle East, and other areas. In the post-war period Kellogg International has grown into an organization of about 500 employees with its office in London.

Mr Liebrecht has been a vice-president and director of Kellogg International Corporation and a vice-president of The M. W. Kellogg Company since 1946.

Her Majesty's Birthday Honours

From a painting by the late Maurice Godner, R.P.

C. A. P. Southwell, C.B.E. M.C.

Congratulations to **C. A. P. Southwell, C.B.E., M.C.,** managing director of Kuwait Oil Company Ltd and a past-president of the IP, upon the Honour of Knighthood which the Queen has conferred upon him upon the occasion of Her Majesty's Birthday.

Mr Southall, who was appointed C.B.E. in the 1953 New Year Honours List, has been managing director of Kuwait Oil Company since the end of the war. Previously he had been with the Anglo-Persian Oil Company from 1930, after service as Petroleum Technologist in Trinidad.

President of the IP for the 1950–51 and 1951–52 Sessions, Mr Southwell was awarded the Cadman Memorial Medal in 1954 and the Silver Medal of the Royal Society of Arts in 1953. He is also a Knight of the Order of St. John.

Other awards of interest to the industry are:

K.B.E.

R. J. Ayres, C.B., C.B.E., deputy secretary, Ministry of Power.

C.B.E.

J. M. Evans, general manager, Shell Oil Company, Thailand.

R. Lessing, president, National Society for Clean Air.

A. W. G. Trantor. For public services in Aden. Mr Trantor is general manager of BP Refinery (Aden) Ltd.

O.B.E.

T. C. Crawhall, assistant director, Mechanical Engineering Research Laboratory, D.S.I.R.

F. J. Dent, director of research, Gas Council Midland Research Station.

R. W. Reynolds-Davies, secretary, Institute of Fuel.

M.B.E.

A. L. Bannister, training manager, Kuwait Oil Company Ltd.

B.E.M.

R. W. Chaytor, engineroom storekeeper pumpman, m.v. *British Faith*, BP Tanker Co. Ltd.

Petroleum in Parliament

Tank-cleaning and Oil-separating Plant at U.K. Ports

On 26 March Mr Neave, Joint Parliamentary Secretary to the Ministry of Transport and Civil Aviation, said that practically all U.K. ports used regularly by ocean-going tankers had tank-cleaning and oil-separating plant provided by the interests concerned. These interests, particularly the port authorities and ship repairers, were well aware of the need to provide the facilities on a competitive basis.

American Capital Investment in Refineries in Britain

In a written answer on 1 April the Parliamentary Secretary to the Ministry of Power stated that gross capital expenditure on oil refineries erected in Britain by subsidiaries of American companies since January 1946 was about £95 million. These companies' capital expenditure was financed very largely by American funds.

IPC Oil Pipelines

In a written answer on 2 April the Secretary of State for Foreign Affairs stated that wayleave rights for the pipelines of the IPC and payments for these rights were regulated by agreements negotiated between the governments concerned and the Iraq Petroleum Company. H.M. Government had had no recent consultations about the pipelines with the governments of the countries through which the pipelines passed.

Proposed Oil Refinery at Fareham

On 15 April the Parliamentary Secretary to the Board of Trade said that an industrial development certificate to erect an oil refinery in the Urban District of Fareham, which was granted to the Regent Oil Company on 7 September 1956, was still valid.

Oil-fired Electricity Generating Stations

On 21 April the Paymaster-General said that one U.K. electricity generating station with dual-firing apparatus was now burning oil exclusively and six others were operating partly on oil. In present circumstances coal could not be substituted for any of this oil without involving the electricity authorities in breach of contract. The oil-firing programme had, however, already been reduced and this would enable power stations to use up to 3 million tons more coal per annum in the nineteen-sixties.

Crankcase Explosions in Diesel Engines

On 22 April the Parliamentary Secretary to the Ministry of Works said that the British Internal Combustion Research Association, supported by the Department of Scientific and Industrial Research, had worked on the basic causes of crankcase explosions in industrial diesel engines and had developed an improved flame trap to confine any explosion, should one occur, and so reduce the danger. The danger of burns to operators was reduced by the suppression of the discharge of flame through valves, thus providing a substantial measure of protection.

On 29 April the Parliamentary Secretary to the Ministry of Works said that the British Shipbuilding Research Association, supported by the D.S.I.R., had carried out fundamental work in collaboration with the Imperial College of Science and Technology on the causes of explosions in the crankcases of large marine diesel engines. This work had led to the development of a photoelectric automatic device to give early warning when dangerous conditions were arising so that remedial action could be taken. The device was now being commercially manufactured following extensive trials at sea. Another device was being developed independently and would also be commercially available.

World Tanker Statistics First Quarter 1958

In the first quarter of 1958 oil tankers under construction throughout the world represented just over half of the world total of tonnage under construction, states *Lloyds Register Shipbuilding Returns*. The figure of 50·2 per cent is made up of 363 tankers of 5,052,802 total gross tonnage, which is an increase of 169,241 tons over the figure for the last quarter of 1957. Of the 363 vessels, 163 of 3,489,900 tons are steamships and 200, of 1,562,902 gross tons, are motorships.

In Britain, at the end of the first quarter, 76 tankers, of 1,069,238 gross tons, were under construction, which is 20,830 tons more than in the last quarter of 1957, and represents 47·2 per cent of total tonnage under construction in this country.

Out of the total of 363 tankers under construction, 77, of 1,133,235 gross tons, are for registration in Britain and Northern Ireland. In terms of tonnage second place is taken

TABLE I

REGISTRATION OF OIL TANKERS UNDER CONSTRUCTION AT END-MARCH 1958

Country of registration	*No.*	*Gross tonnage*	*Country of build*	*No.*	*Gross tonnage*
Britain ...	77	1,133,235	Britain ...	62	878,165
			Belgium ...	2	33,500
			France ...	1	22,000
			Germany ...	3	48,100
			Italy	5	115,000
			Sweden ...	2	35,000
			Unspecified ...	2	1,470
Canada ...	3	32,000	Commonwealth	3	32,000
Argentina ...	1	1,000	... ...	1	1,000
Belgium ...	6	58,298	Britain ...	2	24,000
			Belgium ...	1	12,000
			France ...	1	21,300
			Germany ...	2	998
Brazil	3	46,500	Germany ...	1	4,500
			Netherlands ...	2	42,000
Denmark ...	10	147,900	Britain ...	1	19,000
			Denmark ...	6	90,600
			Italy	1	12,800
			Japan ...	2	25,500
Finland ...	3	14,550	Germany ...	1	900
			Netherlands ...	2	13,650
France ...	15	255,682	Denmark ...	2	36,600
			France ...	12	217,635
			Netherlands ...	1	1,447
Germany ...	29	87,306	Germany ...	29	87,306
Greece ...	1	18,500	Belgium ...	1	18,500
Iran	1	21,000	Netherlands ...	1	21,000
Irish Republic	1	12,000	Britain ...	1	12,000
Italy	16	253,622	Italy	16	253,622
Japan	23	127,810	Japan ...	23	127,810
Liberia ...	29	636,803	Britain ...	2	24,223
			Germany ...	2	14,150
			Japan ...	16	407,250
			Netherlands ...	3	54,000
			Sweden ...	2	28,180
			U.S.A. ...	4	109,000
Netherlands ...	16	150,324	Germany ...	6	6,700
			Japan ...	1	20,700
			Netherlands ...	9	122,924
Norway ...	42	608,460	Britain ...	5	68,100
			Denmark ...	2	25,700
			France ...	1	13,200
			Germany ...	5	89,100
			Netherlands ...	4	73,960
			Norway ...	16	199,025
			Sweden ...	9	139,375
Panama ...	24	553,252	Britain ...	1	18,750
			Germany ...	1	13,900
			Italy	8	163,562
			Japan ...	9	217,440
			U.S.A. ...	5	139,600
Peru	1	4,297	... ...	1	4,297
Portugal ...	2	33,400	Belgium ...	1	17,400
			Unspecified	1	16,000
Russia (U.S.S.R.) ...	6	19,980	Finland ...	6	19,980
Spain ...	13	135,410	Spain ...	13	135,410
Sweden ...	15	233,100	France ...	1	22,000
			Germany ...	2	27,700
			Italy	1	12,000
			Sweden ...	10	159,400
			Unspecified ...	1	12,000
Switzerland ...	2	1,590	Germany ...	2	1,590
U.S.A. ...	17	309,783	Netherlands ...	1	12,500
			U.S.A. ...	16	297,283
Yugoslavia ...	1	13,500	Unspecified ...	1	13,500
Unspecified ...	6	143,500	Britain ...	2	25,000
			Belgium ...	1	12,000
			U.S.A. ...	3	106,500

Of the 363 tankers under construction, totalling 5,052,802 gross tons, 220, of 2,647,977 gross tons were for registration in country of build.

by Liberia which is to be the country of registration for 29 tankers of 636,803 tons. Other major countries of registration are: Norway, 42 vessels of 608,460 tons; Panama, 24 of 553,252 tons; U.S.A., 17 tankers of 309,783 tons, and France with 15 vessels of 255,682 tons. Details of country of build and country of registration are given in Table I for tankers under construction during the quarter.

TABLE II

OIL TANKERS UNDER CONSTRUCTION AT END-MARCH 1958

Country of build	*Steam*		*Motor*		*Total*	
	No.	*Tons gross*	*No.*	*Tons gross*	*No.*	*Tons gross*
Great Britain & Northern Ireland	42	812,468	34	256,770	76	1,069,238
British Commonwealth	1	24,000	2	8,000	3	32,000
Argentina ...	—	—	1	1,000	1	1,000
Belgium ...	4	69,400	2	24,000	6	93,400
Denmark ...	—	—	10	152,900	10	152,900
Finland ...	—	—	6	19,980	6	19,980
France ...	10	214,575	6	81,560	16	296,135
Germany ...	11	211,700	43	83,244	54	294,944
Italy	23	484,624	8	72,360	31	556,984
Japan ...	29	720,190	22	78,510	51	798,700
Netherlands ...	12	223,800	11	117,681	23	341,481
Norway ...	2	33,500	14	165,525	16	199,025
Peru	—	—	1	4,297	1	4,297
Portugal ...	—	—	4	29,470	4	29,470
Spain ...	1	22,000	12	113,410	13	135,410
Sweden ...	1	23,000	22	338,955	23	361,955
U.S.A. ...	27	650,643	1	1,740	28	652,383
Yugoslavia ...	—	—	1	13,500	1	13,500
World total	163	3,489,900	200	1,562,902	363	5,052,802

Germany takes second place to Britain in number of tankers building, with 54 vessels totalling 294,944 gross tons, but this tonnage is far exceeded by Japan's total of 798,700 which is, however, made up of 3 fewer ships. Table II lists tankers under construction, together with their country of build and type of propelling machinery.

TABLE III

TANKERS LAUNCHED DURING THE FIRST QUARTER OF 1958

Country of build	*Steam*		*Motor*		*Total*	
	No.	*Gross tonnage*	*No.*	*Gross tonnage*	*No.*	*Gross tonnage*
Britain & Northern Ireland	3	43,350	7	40,992	10	84,342
Belgium ...	1	17,400	—	—	1	17,400
Denmark ...	—	—	3	44,300	3	44,300
France ...	3	66,685	1	13,200	4	79,885
Germany ...	4	61,430	14	30,508	18	91,983
Italy	3	67,500	2	20,500	5	88,000
Japan ...	9	258,020	23	18,995	32	277,015
Netherlands ...	1	24,960	5	39,297	6	64,257
Norway ...	2	33,500	3	24,745	5	58,245
Spain	—	—	2	17,005	2	17,005
Sweden ...	—	—	8	107,905	8	107,905
U.S.A. ...	4	92,543	—	—	4	92,543
Total ...	30	665,388	68	357,447	98	1,022,835

During the first quarter Britain commenced 12 tankers, launched 10, and completed 11. In the same period Japan commenced 39, launched 32, and completed 25. Germany commenced 23, launched 18, and completed 11. Details of launchings are given in Table III.

HD OILS

The following additional oils have been approved by the Director of Chemical Inspection, Ministry of Supply, as complying with the requirements of Defence Specification DEF-2101-A.

Supplier and supplier's nomenclature	*OMD grade of oil*
B.P. Trading Ltd	
BP 2331	110
BP 2204	60
BP 2329	110
BP 2507	330
Cities Service Oil Co.	
CSR-L-323	110
Alexander Duckham & Co. Ltd	
——	110
Esso Petroleum Co. Ltd	
——	110
Liberty Oils Ltd	
Omegal S. 1 H.D. 30 motor oil	110
Regent Oil Co. Ltd	
GB 2E	110
Shell Petroleum Co. Ltd	
Shell Oil S. 5206	110
Shell Oil S. 5297	110
Société des Petroles Shell-Berre	
Shell Oil S. 5323	330
Stevinson, Hardy & Co. Ltd	
OMD 112 (S.H. 12)	110
C. C. Wakefield & Co. Ltd	
Wakefield H. 180/57	40
Wakefield H. 124/57	110
C.C. Wakefield & Co. Ltd, Wellington, New Zealand	
Deusol C.R. 30	110

MIDDLE EAST OIL PRODUCTION

	April	*Jan.–Apr.*
	Tons	
Iraq Petroleum Co. Ltd ...	1,615,013	6,083,883
Basrah Petroleum Co. Ltd ...	791,064	3,408,640
Mosul Petroleum Co. Ltd ...	104,917	427,362
Qatar Petroleum Co. Ltd ...	713,458	2,649,279
Iraanse Aardolie Exploratie en Productie Mij	3,358,000	13,139,000
Kuwait Oil Co. Ltd ...	5,667,119	22,088,527
	Barrels	
Arabian American Oil Co. (Saudi Arabia)	27,849,205	120,523,159
Bahrain Petroleum Co. Ltd...	1,202,740	5,432,976

The refinery throughput at Abadan of the Iraanse Aardolie Raffinage Mij for April was 1,337,000 tons, the total for 1 January to 30 April being 5,140,000 tons.

Crude processed at Aramco's Ras Tanura refinery during April was 5,087,656 brl, the total for 1 January to 30 April being 22,653,310 brl.

Oil deliveries from Sidon, Lebanon, by Trans-Arabian Pipe Line Co. in April were 11,100,895 brl, the total for 1 January to 30 April being 41,980,876 brl.

Notes of the Month

PLUTO Commemorated

Messages from Sir Winston Churchill and from the U.S. Ambassador (John Hay Whitney) were read out by Geoffrey Lloyd, Minister of Education (wartime Petroleum Minister) when he recently unveiled a plaque at Shanklin, Isle of Wight, to commemorate Operation Pluto, the oil pipeline system under the English Channel which fed the Allied Armies with petrol during the invasion of 1944.

Sir Winston Churchill's message was:

> "Operation Pluto was a remarkable feat of British engineering, distinguished in its originality, pursued with tenacity, and crowned by complete success. This creative energy helped to win the war. But it is no less necessary in peace. There must be no faltering in the drive to nurture in the British people by all possible means, and above all through education, the virtues of skill and inventiveness. These are true characteristics of a virile nation in a technological age."

Mr Whitney's message was:

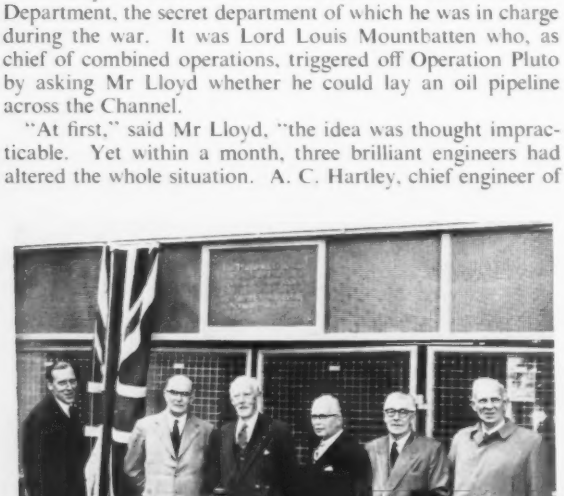
> "Please give my congratulations to those who have organized this most fitting recognition of Operation Pluto. The advance of the Allied mechanized armies across Europe was made possible largely by continuous and abundant supplies of oil. Operation Pluto served as a vital link in the oil supply line between Britain and the Continent. Without it the war would not have been won so soon and the toll of Allied lives would have been greater."

Mr Lloyd referred to the work of the Petroleum Warfare Department, the secret department of which he was in charge during the war. It was Lord Louis Mountbatten who, as chief of combined operations, triggered off Operation Pluto by asking Mr Lloyd whether he could lay an oil pipeline across the Channel.

"At first," said Mr Lloyd, "the idea was thought impracticable. Yet within a month, three brilliant engineers had altered the whole situation. A. C. Hartley, chief engineer of the Anglo-Iranian Oil Company (now the British Petroleum Co.) suggested that a special cable ship might lay a flexible pipeline across the Channel, rather like a submarine cable without the core. Then soon afterwards H. A. Hammick, chief engineer of the Iraq Petroleum Company and B. J. Ellis, chief oilfields engineer of the Burmah Oil Company, suggested that 3-inch diameter steel pipe could be welded into a continuous length and wound on to a 30-ft diameter floating drum—rather like cotton on a bobbin. At the height of the Pluto operation, a million gallons of petrol a day were pumped under the sea to the Continent: in fact, petrol was pumped direct from Liverpool to the Rhine."

"Often the really new ideas cut across conventional demarcation lines," said Mr Lloyd. "In Operation Pluto, 33 different firms co-operated with triumphant success. British industry is again displaying, as for example in the development of atomic power, the same capacity for flexible liaison and courageous decision. That is why we can look back on Operation Pluto without nostalgia and salute it as a fine example of qualities which will give Britain a decisive advantage in the present day."

The ceremony was attended by Sir Donald Banks, K.C.B., D.S.O., M.C., T.D., Director-General of the Petroleum Warfare Department, 1940–45, A. C. Hartley, C.B.E., H. A. Hammick, B. J. Ellis, O.B.E., Captain J. F. Hutchings, C.B.E., D.S.O., R.N., commander of Naval Force Pluto, Commander H. T. Heale, R.N. (Rtd), and others associated with the Pluto project.



Standing before the plaque are (left to right) *Geoffrey Lloyd, Captain J. F. Hutchings, C.B.E., D.S.O., R.N., Sir Donald Banks, K.C.B., D.S.O., M.C., A. C. Hartley, C.B.E., B. J. Ellis, O.B.E., and H. A. Hammick*

Oil Industry Conditions

In his speech at the annual general meeting of The "Shell" Transport and Trading Co. Ltd, the Rt. Hon. Lord Godber, chairman, said:

"In the annual report, I gave a brief description of conditions in the oil industry to-day. The key factor in the situation is the recession in the United States. It has already gone slightly deeper than either of the two previous ones through which the United States has passed since the war and this fact itself, together with other portents, may possibly encourage the view that we may soon see a modest recovery.

"So far as our industry is concerned, the stock position in the U.S.A. is better, owing to much reduced refinery runs and to severe curtailment of production of crude oil, which in the Texas fields has been reduced to 8 days a month—the lowest ever recorded. In the world outside the United States, records of the year so far available suggest that as a whole consumption is being maintained, but without the full impetus to expansion which previous years' experience had led us to expect.

"Within the whole field, of course, some parts of the business have slackened and others have improved. Consumption of bunkers by shipping, for instance, is much lower, because of reduced activity in this sphere; consumption of gasoline and gas oil, on the other hand, still retains much of the characteristic buoyancy of previous years.

"Historically recessions have not had the same impact, except in certain limited fields, on the levels of oil consumption as they have had on the demand for other commodities in general."

U.S. Carbon Black Industry

Production of carbon black in the U.S.A. during 1957 was 2 per cent lower than the record figure for 1956. Although sales increased by 4 per cent, that quantity was exceeded by production and stocks increased by 1·8 million pounds.

Average value of total carbon black produced was 7·12 cents per lb (6·53 in 1956), the average for natural gas black being 8·26 cents (7·68 in 1956) and for hydrocarbon black 7·36 cents (6.79 in 1956).

Details from the official return are given below:

	1956	1957
Number of producers	11	12
Number of plants	42	42
Production:	*Thousand pounds*	
Contact process	363,672	357,557
Furnace process	1,476,296	1,440,868
	1,839,968	1,798,425
Sales:		
To rubber companies ...	1,244,651	1,271,562
To ink companies	42,047	43,153
To paint companies ...	13,231	11,951
Miscellaneous	3,100	4,700
Exports	425,328	459,671
	1,728,357	1,791,037
Value at plant	$120,252,000	$127,979,000
	Million cubic feet	
Natural gas used	242,598	233,788
Average yield per m cu.ft.	3·56 lb.	3·40 lb.
	Thousand U.S. gallons	
Liquid hydrocarbons used ...	242,406	240,413
Average yield per gallon ...	4·03 lb.	4·18 lb.

Institution of Mining and Metallurgy Gold Medal Award

Dr J. F. Thompson, B.S., Ph.D., chairman of the International Nickel Co. of Canada Ltd, has been awarded the Gold Medal of the Institution of Mining and Metallurgy for 1957. The award was made in recognition of his distinguished services to metallurgical science, research, and practice, with special reference to the nickel industry.

Dr Thompson has also received the Rand Medal of the American Institute of Mining, Metallurgical, and Petroleum Engineers for distinguished achievement in mining administration.

New Fellowships at Imperial College of Science and Technology

The following have been elected to fellowships of the Imperial College of Science and Technology, London, S.W.7.

Professor Emeritus V. C. Illing, M.A., M.I.M.M., M.Inst.Pet., Hon. A.R.S.M., F.R.S., formerly Professor of Geology (Oil Technology) at the college.

Professor Emeritus H. V. A. Briscoe, D.Sc., M.Sc., D.I.C., F.R.I.C., F.Inst.F., formerly Professor of Inorganic and Physical Chemistry at the college.

Professor Emeritus A. J. S. Pippard, M.B.E., D.Sc., M.I.C.E., F.R.Ae.S., Hon.A.C.G.I., F.R.S., formerly Professor of Civil Engineering at the college.

Dr S. L. Smith, C.B.E., D.Sc.(Eng.), F.C.G.I., M.I.C.E., M.I.Mech.E., M.I.N.A., M.I.Mar.E., director of research, British Shipbuilding Research Association.

The Honourable H. Fletcher Moulton, M.C., B.A., member of the governing body.

C. A. Bristow, A.R.S.M., B.Sc., A.Inst.M.M., F.I.M., president of the Imperial College Boat Club.

New World Deep Drilling Record

The world's record for deep drilling, established in Louisiana in 1955, was broken on 26 May on a location 13 miles east of Fort Stockton, Texas, when The Phillips Petroleum Company's University EE well No. 1 reached the former record, 22,570 ft, and was heading for greater depths. The hole broke the Texas state record, 21,687 ft, on 28 April.

For the job, Phillips selected its rig 27, a National Supply type 130 rig which it had previously used in Alaska. The only unusual piece of equipment was a hydraulic table, developed by Phillips, which is used to cushion the shock caused by stopping the drill pipe as it is being run, and to prevent a squeeze as the extreme weight of pipe is fitted into slips or clamps. Power is provided by three LeRoi L-4000 Engines, through a 3-section National Supply drive group. The 136-ft Lee C. Moore derrick rests on an 18-ft substructure. It has a total load capacity of 1 million lb.

The well is on an 8100-acre block. Drilling began in October 1956.

Because of the extremely hard formation, drilling is proceeding at about 2 ft/hour. Bits last 75 to 80 hours, after which the entire string of pipe must be pulled and then re-run with a new bit, taking about 12 hours.

Approximately 17,600 ft of pipe fell into the hole last February, when drilling had proceeded to 21,396 ft. Part of the string was recovered by fishing, but it was necessary to leave 39 stands of pipe in the hole and drill around it, starting the new hole at 19,965 ft. Twenty-inch casing was set at 1480 ft, $13\frac{3}{4}$-inch at 6020 ft, and $9\frac{5}{8}$-inch at 10,996 ft.

The deepest production in Texas is at about 15,000 ft, in the Puckett field, 20 miles away, where Phillips is the principal operator.

The world's first oil well, drilled at Titusville, Pennsylvania, in 1859, was only $69\frac{1}{2}$ ft deep, and it was not until 50 years later that a rig drilled to 5000 ft. The 10,000-ft mark was passed in 1931, the 15,000-ft mark in 1938, and the 20,000-ft mark in 1949.

A close-up of the National Supply type 130 *drawworks on the Phillips Petroleum Company's Rig* 27, *shown while drilling the world's deepest well*

British Electrical Equipment for Venezuela

Orders for electrical equipment totalling £1,600,000 have been placed with six British firms in connexion with a project being implemented by Compania Shell de Venezuela for the disposal of crude produced from oilfields around and in Lake Maracaibo.

At Punta Gorda, inside the entrance to the lake, the Company is building an oil terminal called Puerto Miranda, which will be capable of handling very large tankers. The terminal is due to come into operation in stages commencing this year and the whole project is to be completed during the second half of 1960.

Some 170 km of trunk pipelines will feed the terminal from oilfield dispatch points at Bachaquero, Lagunillas, and Cabimas on the eastern shore of the lake. An order worth over £500,000 has been placed with the South Wales Switchgear Co. Ltd for switchgear and control gear for valves, etc., associated with the electrically driven pumps, which range in size from 500 hp to 2500 hp. Both pumps and motors are being manufactured in Holland.

Electricity for the project, excluding the terminal proper, will be supplied by Compania Shell de Venezuela's power station at Las Morochas, which is being extended by the addition of three 20 MW gas turbo-generators costing nearly £2 million. One will be American built and the other two will come from Switzerland. The high-tension switchgear and main control boards will be supplied by A. Reyrolle & Co.

All the distribution equipment has been ordered in Britain. Main distribution will be by new twin single-circuit 115 kV and existing 69 kV transmission lines, the former being supplied by British Insulated Callender's Construction Co. at a cost of over £200,000 for the material alone. There will be two step-up and two step-down switching sub-stations for 115/34·5 kV, part designed and supplied by the English Electric Co., costing £150,000, part by A. Reyrolle & Co., whose orders in connexion with the power station extension and step-up sub-station amount to some £200,000. The 115 kV sub-stations will each contain two main transformers rated at 40 MVA ratio 115 34·5 kV and fitted with on-load tap changing gear. They have been ordered from the British Thomson Houston Co. at a cost of £300,000.

Local distribution from the 115 kV grid will be by the existing overhead lines, reinforced where necessary with additional 34·5 kV switching stations. These are on order with the South Wales Switchgear Co. and A. Reyrolle & Co., utilizing transformers on order with C. A. Parsons & Co., English Electric Co., and Crompton Parkinson Ltd. The total cost involved here is a further £250,000.

British Car Wins British Mobilgas Economy Run

The outright winner of the recent British Mobilgas Economy Run, organized by the Hants & Berks Motor Club under R.A.C. supervision, was a Standard Sportsman which recorded a figure of 61·23 ton-mpg over the 1023-mile course. The mpg figure of the Standard, which also won the class for cars of over 2000 cc capacity, was 40·02.

Other class winners were:—

Class I (under 1000 cc): Citroen 2 CV with 53·79 ton-mpg (69·05 mpg)

Class II (1000–1600 cc): Volkswagen with 49·32 ton-mpg (49·47 mpg)

Class III (1600–2000 cc): Citroen ID 19 with 59·80 ton-mpg (42·56 mpg).

The Engineer's Place in the World To-day

Obligations to himself, his profession, and society are the three forces which put the engineer of to-day in an almost unique place in the world, said R. J. Schilthuis, a director and vice-president of Humble Oil and Refining Co., during a recent keynote address to the main session of the 24th Annual Engineers' Day at the Colorado School of Mines.

Recent events, such as the launching of earth satellites had brought the essential nature of the scientific man and the engineering profession into even sharper focus. "Yet," said Mr Schilthuis, "as dramatic as these developments have been, it is the only logical climax of a historical movement evident for centuries."

The engineer was the central figure in a network of activities basic to man's existence. Furthermore, "because of his broad knowledge of the physical world, the engineer is called upon to share his knowledge in the planning, promoting, and development of practically every major public and private enterprise."

Awards were presented to P. A. Wichmann, petroleum engineering senior from Calgary as outstanding senior, to D. F. Bailly, petroleum geology junior from Pasadena, California, as outstanding junior, and to L. P. Sydejko, senior from Chippewa Falls, Wisconsin, for the most promising geophysics student.

Chairman of this year's programme was P. J. Sanger, a petroleum engineering senior from Englewood, Colorado.

New Radiochemical Laboratories for U.S. Bureau of Mines

Establishment of two new radioisotope tracer laboratories for the U.S. Bureau of Mines at Reno, Nevada, and Salt Lake City, Utah, has recently been announced.

At Reno research is in progress on more efficient methods of extracting and separating the rare earths, and so-called "activation analyses" are being made to detect traces of impurities in extremely pure metals, also known as hyperpure metals.

At Salt Lake City irradiated chemicals, compounds, and minerals will be used in investigating various metallurgical processes. By following radioactively "tagged" compounds with radiation detectors, scientists will be able to find out what reactions occur in such processes as roasting and flotation in extracting metals from their ores.

Pioneering studies on the use of radioactive materials in mineral research began at the Bureau's Petroleum Experiment Station in Bartlesville, Oklahoma, in 1951. This laboratory conducts research on radioisotopes placed in water pumped underground to force oil toward producing wells, and the radioactive tracers determine the efficiency of the water-flood system.

New BCPMA Officers Appointed

At the recent Annual General Meeting of the British Chemical Plant Manufacturers Association, H. W. Fender, M.Inst.B.E., A.C.I.S., was elected chairman for the ensuing year.

At its quarterly meeting following the Annual General Meeting the Council elected as vice-chairmen N. C. Fraser, M.A., M.I.Chem.E., M.Inst.Pet. (*W. J. Fraser & Co. Ltd*); Dr R. Lessing, Ph.D., F.R.I.C., M.I.Chem.E., F.Inst. Pet. (*The Hydronyl Syndicate Ltd*); and P. W. Seligman (*A.P.V. Co. Ltd*). The hon. treasurer is M. Wyndham (*Bennett, Sons & Shears Ltd*).

BP's Purchases in the U.K.

During 1957 BP Trading Ltd (BP's principal trading subsidiary) placed orders for materials, equipment, and services to the value of £19·5 million. Of this total, orders worth £18 million were placed in the United Kingdom, approximately 44 per cent of this amount being for export.

In addition, refineries and other main subsidiaries of BP in the United Kingdom placed during the year orders valued at about £3 million to cover their local requirements. Orders valued at £500 and over were divided among approximately 600 suppliers in the United Kingdom.

Shipments of materials to overseas destinations by sea and air covered some 20,000 consignments amounting to just under 100,000-dw tons, at a freight cost of £1 million.

In addition, BP's shipping organization, BP Tanker Company, last year purchased in the United Kingdom provisions and materials to the value of £2·7 million. Another £600,000 was spent in purchases at foreign ports.

New Shell Agricultural Research Laboratory in California

A new agricultural research laboratory has been opened at Modesto, California, by the Shell Development Company. The centre is now three times as large as the original research unit, which was opened in 1946, and the new buildings have 50,000 sq. ft. of floor space.

Research at Modesto covers the broad range from pure research, through investigations of plant growth and behaviour, to applied research aimed at the discovery of new agricultural chemicals for specific purposes.

Research projects in the biological sciences are carried out in plant physiology, plant pathology, entomology, and nematology. An organic chemistry group is primarily concerned with the synthesis of new compounds, and a physical and analytical chemistry section develops new formulations and conducts the residue studies necessary before an agricultural chemical can be marketed. The products application group co-ordinates the efforts toward development of chemicals as they approach the commercial stage, and extends the research from the Modesto laboratory to farms throughout the United States.

The new laboratory is one of three major research establishments of Shell Development Company in America. The others are the Emeryville Research Centre in California, which employs more than 1500 persons in fundamental and applied research, and the Houston Exploration and Production Laboratory, Texas, where 500 employees are concerned with the development of improved methods of finding oil and withdrawing it from the ground.

In Britain agricultural research for Shell is carried out at Woodstock Research Centre, near Sittingbourne.

New Standard Oil Affiliate in Norway

A new refining affiliate company of Standard Oil Co. (New Jersey) has been established in Norway with its headquarters in Oslo. The new company, which is known as A/S Esso-Raffineriet, Norge, was formed to supervise the planning, construction, and operation of what will be Norway's largest refinery.

Norval F. Myers, formerly deputy refining co-ordinator for Jersey Standard, has been appointed chairman and managing director of the new affiliate, and Gustav A. Stein has become a member of the board of the new company and a managing director.

First 42,000-ton BP Tanker Launched

The Duchess of Gloucester recently launched from the shipyard of John Brown & Co. at Clydebank BP Tanker Co.'s first 42,000-ton tanker.

The new vessel, which is named *British Duchess*, has an overall length of 710 ft and a breadth of 95 ft. Her single screw, driven by steam turbines, will give her a loaded service speed of 16 knots.

BP Tanker Co., whose biggest tankers at present in service are of 35,000 tons, has on order six other vessels of 42,000-dw tons but tankers of up to 65,000-dw tons are also being constructed for the Company.

British Duchess *after her launching*

Oil Firing Display at Building Centre

Recently opened at the Building Centre, Store Street, London, W.C.1, by Lady Barnett, is a permanent and comprehensive display of nearly 50 oil-fired domestic appliances. It is a considerable improvement on the previous display, advantage having been taken of facilities available in the new part of the Centre. Organized by Shell-Mex and B.P. Ltd, it comprises various types of appliance for use in houses of different sizes and also systems whereby hot air is circulated through ducts and grilles.

Speaking at the opening ceremony, C. M. Vignoles, C.B.E., managing director of the Company, said that all the appliances were well-tried and their counterparts were at work in all parts of the country. Oil was no longer a luxury. It was a little dearer than solid fuel but was the cheapest for automatic heating all over the house. There were the added benefits of cleanliness and elimination of drudgery.

Welding Training Centre in Northern Ireland

Some two years ago the Northern Ireland Ministry of Labour and National Insurance realized that a shortage of skilled men, particularly welders, was delaying implementation of a long-term scheme to build factories in Northern Ireland. Accordingly, after consultation with Welding Supervision Ltd, the Ministry established a training centre for welders at Felden House, Belfast.

At this centre 3-month courses are given to classes normally consisting of 12 selected unemployed men who either lack previous experience or possess insufficient metallic arc welding experience. Tuition is given in gas cutting and joint preparation and some of the initial trainees have now become competent argon arc welders or are welding high-pressure pipe joints to ASME and API standards.

BP Touring Service

To those motorists planning to tour on the Continent this year, the BP Touring Service offers considerable assistance both before and during the trip. At the planning stage the motorist collects from his BP garage an application form to complete and send to BP. In return he will receive "The Planning Kit". This consists of a map of the main highways of Europe, including the U.K. and Eire, with on the reverse another map indicating the heights to be encountered on any journey.

Attached to the map is a series of coupons which can be exchanged at a BP garage in the country in which the motorist finds himself for "The En Route Kit". This consists of a map of the country and information of value to the tourist, together with a souvenir gramophone record ($33\frac{1}{3}$ rpm) devoted mainly to the music of the country.

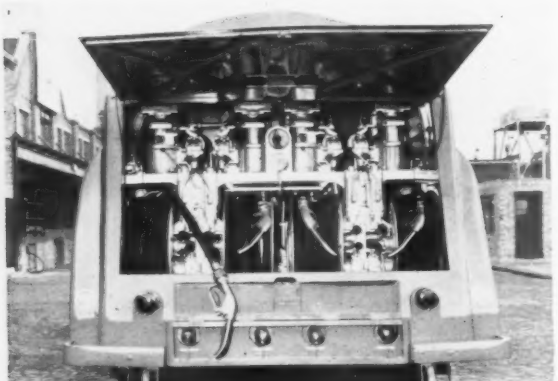
The countries covered are Austria, Belgium, Denmark, France, Great Britain, Greece, Germany, Italy, Netherlands, Norway, Portugal, Sweden, Switzerland, and Turkey. The first kit also includes a useful conversation guide, particularly for the motorist, in twelve languages.

Honorary Degree for American Industrialist

At a recent ceremony at the St Boneventure University, New York, the honorary degree of Doctor of Commercial Science was conferred on J. B. O'Connor, president of Dresser Industries Inc., Dallas, Texas.

Mr O'Connor is head of one of America's leading manufacturers of equipment for the oil, gas, and chemical industries and among his achievements was the development of high-speed engine-driven angle compressors for oilfield service. He also built the first complete gas liquefaction plant in Russia and one of the first repressurizing systems in America.

New Vehicles for Mobil's Road Tanker Fleet



The Mobil Oil Company have recently introduced to their road tanker fleet Austin 1200-gallon lubricating-oil dispensing vehicles for on-the-spot deliveries to service stations and individual customers. Each vehicle can carry four grades of oil in separate compartments, delivery being made by preset meters and 50-ft hoses on hydraulically rewound reels. A general view of the meters and hose reels is shown above. In addition, each vehicle can carry assorted packages of oil and grease.

Assessment of Esso Experimental Road

A team of road engineers, including representatives from the Ministry of Transport, the local County Council, the Road Research Laboratory, and various Esso Companies in Europe, recently inspected the $1\frac{1}{2}$-mile stretch of experimental road laid down near Wallingford, Berks in 1954 by Esso Research Ltd. After four years' wear it was found that little difference was discernible between the different compositions in the 59 test strips, although it was expected by Esso Research at the start of the experiment that certain bitumens, reputed to be rather inferior, would declare themselves within two years.

Although little change was apparent in the road itself samples cut from the surface and tested in the laboratory have yielded valuable information about the changes bitumen undergoes in service.

Oil Spray Combats Banana Disease

A new oil spray has been developed which successfully combats the destructive banana plant fungus disease known as Sigatoka. The fungus attacks the leaves of the plants, causing a characteristic leaf-spot. As the leaves wither and die, the plants produce smaller and fewer bananas, as well as fruit that ripens prematurely.

Development of the fungicide resulted from a joint research programme by Esso Research, the central scientific organization of Standard Oil Company (New Jersey), and Esso Standard Oil Company (S.A.), which manufactures and markets Esso products in the Caribbean area. In extensive fields tests in Jamaica, the new fungicide reduced the disease in badly-infected areas by 92 per cent after two months of fortnightly spraying. The remaining 8 per cent of infection is considered negligible.

Until a few years ago, banana growers in the Caribbean relied almost exclusively on a copper sulphate and lime fungicide in attempts to control Sigatoka, but this mixture had to be combined with large quantities of water (150 gallons per acre) for use as a spray, and water is scarce in some regions of the Caribbean. In addition, the copper sulphate-lime mixture required a considerable amount of expensive spraying equipment to handle the large water volume necessary.

Initial experiments with oil were undertaken by the French Government in the island of Guadelupe. Esso Standard Oil Company (S.A.), working closely with banana experts in both Guadelupe and Jamaica, developed an oil fungicide that appeared to be the answer to Sigatoka. By last year, this oil spray had proved sufficiently effective in Jamaica for the All-Island Banana Growers Association to approve it as the first petroleum spray recommended for use.

Esso Research undertook to develop this new and improved oil spray so that could be manufactured in quantity—and to do the job before the growing demand overtook existing output. More than 20 different oil compounds were tested in laboratory and field applications over a 14-month period. The fungicide is applied directly to banana plants as a fine mist or fog, with two gallons effectively covering an acre. Because of this low volume, portable knapsack-sprayers can be used on small banana farms. For large plantations, helicopters and fixed-wing planes can be used to spray 18 acres in about ten minutes.

Murals for BP Staff Restaurants

To foster the art of mural painting among students and ex-students of art schools and to add to the decoration of four new restaurants built for their employees the BP Co. in 1956 held a competition for murals for these restaurants. Shown above is the 50-ft long mural at Kent refinery. Painted by Stanley Jones of Birmingham it is based on scenes in the Medway area as it must have appeared in the early nineteenth century

Trans-Antarctic Snocat on Show in Britain

After its 2150-mile journey through snow and ice in the Trans-Antarctic Expedition, the Snocat tractor Haywire, which has been presented to the British Petroleum Co. Ltd by Sir Vivian Fuchs, is now being shown in various towns throughout Britain. Its first appearance was in Trafalgar Square, London. During the latter part of May and throughout June it has been on display in the Midlands, east, and north-eastern England, and from 10 to 23 July it will be seen in five towns in Scotland. This will be followed by visits to Blackpool, Manchester, Southport, Cardiff, and Bristol. In the middle of August the tour will be concluded by visits to Bournemouth, Southsea, Brighton, and Eastbourne.

Haywire is the only Snocat to be displayed in Britain. The tractors were manufactured by the Tucker Corporation of America and are fitted with Chrysler V8 engines. Their fuel consumption was about 1 mpg and each machine required about 2000 gallons of petrol for the Trans-Antarctic crossing.

All fuels and lubricants for the Expedition were supplied by the BP Co. Ltd at its own expense. The petrol used was specially made to facilitate engine starting in sub-zero conditions and to remain fluid at temperatures below −112° F. The lubricating oils were blended to give adequate lubrication at normal temperatures but to remain fluid at temperatures as low as −65° F.

Smokeless Safety Flare for Refineries

An oil refinery safety flare that burns with no smoke and no visible flame has been designed by the Esso Research and Engineering Company, and has been proved during 16 months' use at the refinery operated at Halifax, Canada, by Imperial Oil Ltd.

The new flare, which is part of Esso's contribution to the reduction of air pollution, burns gas at the base of a 38-ft steel stack which is lined with refractory material. The base of the flare is several feet above the ground and contains one or more rows of multi-jet burners. Solid rods of refractory material mounted above these burners act as flame holders so that the gases burn only above the flame holders.

Refineries operated by Jersey Standard affiliates, such as Imperial Oil Ltd, have used steam injection at elevated flares or water injection at ground flares to reduce smoke and flame. The new flare, however, requires no steam or water. Esso Standard Oil Company is studying the application of the new flare to existing refineries, but its chief use will be in new ones, and six such flares are planned for plants now being built.

Work Begun on New Buildings for University College London

Work began recently on the new addition to the Engineering Departments of University College, London at Torrington Place. This building is the first stage in the College's £2 million expansion project, and has been made possible by the subscription of £371,000 from British industry, together with the £380,000 allotted by the University Grants Committee.

In 1956 Lord Cohen, chairman of the College Committee, and Lord Strang, chairman of the Engineering Appeal Committee, issued a joint appeal to industrial firms in the U.K stressing that engineering students were graduating at a rate falling far short of the national demand. Owing to inadequate accommodation and facilities, the College could accept only one of every nine applicants, and of them at least seven were suitable for entry into the Engineering Departments.

On completion of the new building U.C.L.'s output of trained engineers will be increased by some 50 per cent to over 100 a year. As further funds become available two large additional wings will be added. The College will then be able to accommodate about 600 engineering students, corresponding to an annual intake of approximately 200, including candidates for higher degrees.

IP Conference

on

Molecular Spectroscopy

Over 300 delegates attended the second Conference on Molecular Spectroscopy held by the Hydrocarbon Research Group of the Institute of Petroleum (the first being in October 1954) at the Institution of Electrical Engineers, Savoy Place, London, on 27–28 February. The organizing committee, consisting of Dr H. Powell (chairman), E. Thornton (secretary), Dr H. W. Thompson, F.R.S., Dr Rex Richards, and R. C. Hawkes, arranged a full and varied programme and, in all, twenty-two papers were presented.

After an introductory address by the chairman of the Group, Dr J. W. Barrett, the conference opened on Thursday morning, under the chairmanship of Dr H. W. Thompson, F.R.S., with three papers on nuclear magnetic resonance spectroscopy which illustrated the potentialities of this relatively new addition to the physical methods available for molecular structure determination. Dr R. E. Richards (Oxford), in considering the "Practice and applications of nuclear resonance spectroscopy", gave a good indication of the general use of the method in such fields as structural diagnosis (particularly structural group determination), qualitative and quantitative analysis of mixtures, and the study of chemical equilibria. In a discussion of experimental methods, Dr Richards gave an account of the relative merits of available equipment, and showed the sort of results that could be obtained using reasonably simple arrangements.

Dr H. Powell, Prof. W. C. Price, with three of the Russian delegates—Mrs K. I. Zimina, and D. M. Shigorin from Moscow and U. Buianov of the Russian Embassy, London—and Sir Eric Rideal

E. Thornton, secretary of the Spectroscopy Panel, Prof. F. H. Garner, Dr H. W. Thompson, Dr J. W. Barrett, and Dr H. Powell, discussing serious topics

The paper, "Nuclear magnetic resonance in petroleum analytical research", by Dr R. B. Williams (Humble Oil Co., Texas), described fully the uses to which NMR has been put over a number of years in analytical research on petroleum products. His discussion dealt with the proof of molecular structure of pure compounds, the quantitative analyses of simple mixtures, the characterization of hydrocarbon types in complex petroleum fractions, and with methods for the determination of total hydrogen content. These illustrated the essential similarity of the methods of procedure in NMR to those used in other branches of spectroscopy whilst pointing out the relative simplicity of the NMR spectra. No direct evaluation of the method in relation to other spectroscopic methods was made, but for such problems as the determination of certain structural groupings it was clear that NMR provides a rapid solution.

Certain theoretical aspects of NMR spectroscopy were dealt with by H. Primas (Swiss Federal Institute of Technology). He considered briefly, and without proof, some quantum mechanical approximations to the spectral intensities and frequencies. Details of his work are to be published in *Helvetica Physica Acta*.

After a lively discussion on the techniques and uses of NMR spectra, there followed a description of some interesting results in different fields obtained by Prof W. C. Price (King's College, London) and by Dr A. G. Gaydon, F.R.S. (Imperial College, London).

Prof. W. C. Price in his paper on "Ultra-violet spectra and ionization potentials of hydrocarbon molecules" described a new method for the determination of molecular ionization potentials by direct photoionization using a vacuum uv monochromator. The method allows the determination of the ionization potentials of large classes of molecules more accurately than electron impact methods, giving values more suitable for relating to molecular structure. Prof. Price considered the results on hydrocarbons in terms of stabilization energies in both the ground and the ionized states, and concluded that, although a general interpretation can be given, the factors affecting the ionization potentials are incompletely understood.

Dr Gaydon, in "The shock tube as a source for studies of emission and absorption spectra", showing how bursting diaphragm shock tubes can be used to obtain short-term high temperatures (up to 18,000° K) in gases in order to study thermal emission spectra. The method has possibilities

in investigations on stellar type spectra, excitation and collision processes, and in combustion reactions.

A preliminary analysis of the results obtained in a new examination of the uv and ir spectra of a large number of methyl biphenyls was then offered by Dr G. H. Beaven (National Institute for Medical Research). Many new compounds have been investigated in this careful work, but it would seem that, as yet, no really new ideas about the spectra have been evolved.

The chair was taken by Sir Eric Rideal, F.R.S., on Thursday afternoon to begin a series of papers on infra-red and Raman spectroscopy, a series which comprised the main bulk of the contributions to the conference.

Dr S. F. Orr (Perkin Elmer A. G. London), in "Recent advances in infra-red instrumentation", spoke initially about the new low-cost double beam infra-red instruments (Baird KM-1, Beckmann IR5, Perkin Elmer 137) designed as routine bench instruments, and pointed out the probable additional use of these in teaching institutions. The use of filters in grating instruments in eliminating the need for a fore prism was then shown to have led to the development of simple monochromators of quite high performance (*e.g.*, Mervyn, NPL.) and to a ready extension of the ir range to 200μ. Dr Orr, however, considered that a further development of the prism-grating combination as a wide range routine instrument was likely, especially as the transfer of intensity data in quantitative analysis was more likely with such instruments. The speaker ended with a consideration of differential and scale expansion methods in trace component analysis and with other microspectroscopic techniques.

Dr A. E. Martin (Sir Howard Grubb, Parsons Co.), in "Multiple differentiation as a means of band sharpening", described with illustrations the effects of successive differentiation on band shapes and showed how band overlap can be resolved by recording the second derivative of the absorption band. A brief description of the practical methods for recording the derivative spectra was given. This talk was followed immediately by an example of the actual use of this method by G. L. Collier (ICI, Northwich)—"The use of derivative spectroscopy for determining methyl groups in polythene". By using the second derivative of the methyl absorption band at 1378 cm^{-1}, band overlap with the methylene band (1358 cm^{-1}) was avoided and very low methyl contents could be determined. Detailed consideration was given to the practical aspects of the problem with a complete description of the derivative unit.

The use of the difference method in the near ir was described by H. A. Willis (ICI, Welwyn) who pointed out the advantages of this region in the difference analysis of liquid and solid samples where control of sample thickness to an accurate degree was necessary in order to achieve major component cancellation. The estimation of monomer in polymethyl methacrylate was chosen as one example and a simple wedge-shaped reference for easy balancing described.

An investigation of the Raman spectra of hydrocarbons carried out by T. Yoshino and H. J. Bernstein (NHC, Canada) was read by Dr N. Sheppard. Using a photoelectrically recording spectrometer, the intensities of the polarized bands of gaseous methane, ethane, neopentane, benzene, ethylene, and acetylene, were used to derive the derivatives of the mean polarizability per bond. In contrast to dipole moment derivatives, the polarizability derivatives for CH bonds were found to be independent of the state of hybridization of the C atom, whilst the derivatives for CC bonds appeared to be directly proportional to the bond multiplicity.

Dr H. W. Thompson, F.R.S. (Oxford), on "Vibrational band intensities and structural factors", began the Friday morning session (Prof. J. A. A. Ketelaar being in the chair) with a summary of the current position regarding the effect of instrumental factors on absorption band parameters (half-width, integrated intensity, absorbance). He showed that bands did not reveal their true character unless the effective spectral slit width was about one-fifth of the true half band width and reliable values for absorbance required effective slits of 1 cm^{-1}. In quantitative analysis, Dr Thompson considered that it might still be desirable to measure such absorbances rather than integrated intensities, especially when there was band overlap, but he stressed the need for more fundamental work on band shapes.

He dealt, in addition, with the recent and extensive work concerned with the effects of substituents on the intensities and frequencies of characteristic group vibrations and their relation to Hammett σ factors, with some mention of the possible division into inductive, resonance, and stearic components.

From the theoretical standpoint, the most interesting and thought-provoking talk was that given by Prof. C. A. Coulson, F.R.S. (Oxford) on "Some theoretical considerations about vibrational band intensities". Prof. Coulson dealt with the difficulties inherent in calculations on vibrational band intensities through dipole moment derivatives. His considerations included the distortion of molecular charge clouds in condensed phases and the effects of lone pair electrons and hybridization changes. He described in some detail the idea of partial bond following where angular displacements led to "bent" bonds as the result of incomplete following of the bonds by charge clouds. As the result of this, Prof. Coulson considered it necessary, in accurate calculations, to treat the molecule as a whole without explicit reference to chemical bonds. Less detailed calculations could be made using the conventional ideas about bond moments as long as these included cognizance of lone pair electrons and of both transverse and longitudinal components of the effective bond moments.

These latter calculations would clearly lead, as Prof. Coulson pointed out, to a greater chemical insight into the factors determining band intensities.

The current unsatisfactory position regarding solvent effects on infra-red frequencies and intensities were dealt with in new approaches described by Dr. C. la Lau (Amsterdam) and Dr L. J. Bellamy (Waltham Abbey).

Dr Lau, in "Solvent effects in infra-red spectra of some aromatic compounds", was concerned with the γ-CH vibrations of aromatic compounds. He noted the inadequacy of the Kirkwood-Bauer-Magat relation relating frequency shifts to the bulk dielectric constant of the medium, and showed how, in a semi-quantitative way, the observed shifts could be accounted for on the basis of localized electrostatic interactions.

Band intensities, which showed little variation, could not be accounted for on the basis of any of the existing theories, and Dr Lau suggested that the treatment of the medium as a continuum was questionable.

Frequency shifts in a wide variety of solvents, particularly for compounds containing X-H groups, were dealt with in a novel way by Dr Bellamy in "Solvent effects on infra-red frequencies".

He related the shifts for a series of solutes to those of a standard solute in the same range of solvents and the results indicated, once again, that the effects arose from a local

Prof. J. A. Ketelaar (Amsterdam) and Dr H. Powell

di-polar association between solute and solvent. One striking example which well illustrated the relative unimportance of dielectric constant was the effect of mixed solvents. Three separate absorption bands were observed for pyrrole in a mixture of three solvents, each at the frequency observed in the separate pure solvents. All three were observable over a wide range of solvent concentrations corresponding to a large change in the overall dielectric constant.

Prof. D. N. Shigorin (Moscow) in his paper on "Infra-red absorption spectra study of H-bonding and of metal-element bonding" presented reasons for spectral changes due to hydrogen bonding energy in systems where there are no π electrons. Mechanisms and conditions of interaction of π electrons with intermolecular hydrogen bonds and metal element bonds were discussed, the former with particular reference to the spectrum of acetylacetone. The spectra of the lithium alkyls and lithium phenyl in the vapour and crystalline states and in solution in non-polar solvents were presented as examples of metal bonding formed without acceptor-donor interaction.

The last paper on Friday morning was by Prof. B. Vodar on the "Spectroscopic study of intermolecular forces in gaseous mixtures". In this he presented an outline of the effect of pressure on molecular ultra-violet and infra-red spectra in gaseous mixtures. The observed phenomena were discussed under two main headings:

1. Shift of wavelength of spectral bands under pressure (pressure effects) and
2. Bands induced by pressure (intensity effects).

He also put forward a possible explanation for the appearance of the "satellite" bands observed in the electronic spectra of metal vapours in a highly compressed foreign gas.

Friday afternoon, with Prof. Foil A. Miller in the chair, saw the conference draw to a close with descriptions of spectroscopic work in rather more specialized fields.

Dr N. Sheppard (Cambridge), on "Infra-red spectra of absorbed molecules", gave a review of the progress so far achieved in this field and drew attention to the great potential value of the method for studying adsorption.

The information which could be obtained from such studies included (*a*) the nature of the forces binding the molecules to the surface, (*b*) the existence and nature of two types of site, (*c*) the degree of freedom of rotational motion on the surface, and (*d*) the effective electric field at the surface.

Dr Sheppard dealt with the experimental difficulty inherent in this type of investigation due to loss of radiation by surface scattering and absorption by the adsorbent, and stressed that formidable obstacles of this kind had to be overcome before complete cover of the adsorption field by infra-red spectroscopy could be said to have been achieved.

Prof. J. A. A. Ketelaar (Amsterdam), on "Infra-red spectra of compressed gasses", brought together the results obtained in this field. He dealt with the two main effects which arise at pressures in the range 10–100 atm, namely, inducement of otherwise forbidden bands, and, in gaseous mixtures, the existence of new bands due to simultaneous transitions observed at frequencies equal to the sum and difference of frequencies of both components. An outline of a quantitative theory of simultaneous transitions was given and the formal analogy to the Raman effect pointed out.

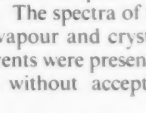
The value of the method as a tool for studying molecular interaction was stressed.

Prof. G. Porter (Sheffield) on "Recent progress in free radical spectroscopy", reviewed the techniques which were being used in the study of free radicals and other unstable molecules and which had appeared during the last ten years. The methods included the use of shock waves, flash photolysis, and paramagnetic resonance spectroscopy.

Free radical stabilization by the matrix isolation technique was discussed and the use of this method to extend investigations into the infra-red region where very rapid recording techniques were not available was noted. Prof. Porter considered that useful developments of the field should come from electron magnetic resonance studies of such "trapped" radicals.

The paper by Prof. M. M. Suschinski (Moscow) on "Structural analysis of hydrocarbon molecules based on the Raman spectra", dealt with the relationship between the spectra and molecular structure of α olefins and paraffins.

The presence of characteristic lines having an aggregate of characteristic parameters, *e.g.*, frequency, intensity, degree of polarization, due to certain structural elements



was established. These are generally additive though exceptions were noted. The length of the longest free chain, m carbon atoms (including the branch carbon atom from which the chain begins) may be estimated from the frequency of the line in the region below 500cm^{-1} which has the highest intensity, largest polarization, and least width, using the formula $\Delta \nu = \frac{a}{m+6}$ where a is a constant depending on the other structural elements in the molecule.

The final paper, by C. R. Wilkinson, W. C. Price, and D. M. Bradley (King's College, London), on "The application of polarized infra-red radiation", presented (*a*) an outline of the theory necessary for the interpretation of the spectra of oriented materials obtained with polarized radiation, (*b*) a brief description of the experimental techniques used in the spectrophotometry and preparation of oriented specimens, and (*c*) a review of the scope of polarized infra-red radiation to the study of molecular spectra. Special reference was made to the use of polarized radiation in conjunction with a double beam microscope in the study of organic crystals and of both synthetic and natural high polymers.

The Conference Dinner

The Conference Dinner was held on the evening of 27 February at the Rembrandt Hotel, the chair being taken by Professor F. H. Garner, O.B.E., a past-president of the Institute of Petroleum. About 160 members of the Conference were present.

The chairman, outlining the origin of the IP Hydrocarbon Research Group, said that it arose from the need during the war to develop new methods for the analysis of aviation fuels and the panel then set up by the Ministry of Aircraft Production was at first mainly concerned with infra-red spectroscopic methods and synthesis of hydrocarbons. At the end of the war it was decided that the organization should continue as the IP Hydrocarbon Research Group. Since then the Group had developed considerably but its Spectroscopic Panel was the body responsible for the present conference which had attracted over 300 delegates, many of whom came from overseas.

Proposing the toast "The Hydrocarbon Research Group", Dr N. Sheppard said that he first became associated with the Group's work in 1943 while working at Cambridge with Dr G. B. B. M. Sutherland on infra-red spectroscopy. He felt that the Group performed a very useful function in bringing together those concerned with hydrocarbon research, whether they were working in universities or in industry. That was all to the good of the scientific effort in Britain and, he thought, was well brought out in the success of the conference now in session.

Replying on behalf of the Group, Dr J. W. Barrett, its chairman, said that thanks were due to the Institute for the interest it had shown in the Group and for its help in past years in its activities. The main purpose of the Group was to administer the funds collected from the sponsoring bodies and to allocate them to the various universities, where they were applied to the search for greater knowledge of hydrocarbons and the techniques of obtaining that knowledge.

Dr Barrett said that about £100,000 had been spent on the work and that the results obtained had been of considerable importance and value. The work would continue.

Concluding his remarks, Dr Barrett said that special thanks were due to the members of the Spectroscopic Panel, and particularly to its chairman, Dr H. Powell, and its honorary secretary, E. Thornton. They had organized a very fine conference.

The health of "The Overseas Guests" was proposed by Dr H. Powell, who said it gave him particular pleasure to welcome spectroscopists from all parts of the world. Present at the conference were delegates from Belgium, France, Germany, Holland, Japan, Switzerland, the U.S.A., and the U.S.S.R. It was especially gratifying to the Panel to see so many from overseas and this was a complete recompense for their efforts.

Professor Foil A. Miller, a Fellow of The Mellon Institute, expressed the thanks of his fellow overseas guests for the opportunity of attending the conference and of meeting one another. The conference had been extremely well arranged and they were happy to participate in its work.

The Exhibition

Associated with the Conference was a small exhibition of British-made spectroscopic equipment, the companies participating and the items exhibited being as follows:

Grubb, Parsons, Newcastle-upon-Tyne.—Model DM1 infra-red grating spectrometer and non-dispersive gas analysers.

Hilger & Watts Ltd, Camden Town.—Model H800 infra-red spectrophotometer with micro-illuminator attachment.

Joyce Loebl & Co. Ltd, Newcastle-upon-Tyne—Double beam recording spectrophotometer, 1850–10,000A°.

Mervyn Instruments, Woking.—Infra-red grating spectrometer.

Research & Industrial Instruments, London.—Variable thickness cells and other ancillary equipment for absorption spectrometry.

In addition, the DMS punched card system for the filing and sorting of spectra, the publication and distribution of which is undertaken in the U.K. by Butterworths Ltd, and the Sadtler (U.S.A.) catalogue of spectra were displayed.

AT THE CONFERENCE DINNER

Toasting "The Hydrocarbon Research Group"

Proposed by Dr N. Sheppard

Replied to by Dr J. W. Barrett

The chairman Prof. F. H. Garner, O.B.E.

Toasting "The Overseas Guests"

Proposed by Dr H. Powell

Replied to by Prof. Foil A. Miller

Around the Branches

BAHRAIN, ESSEX, FAWLEY, KUWAIT, LONDON, NORTHERN, SCOTTISH, SOUTH-EASTERN, SOUTH WALES, STANLOW, TRINIDAD

Bahrain Branch

The thirty-fifth ordinary meeting of the Bahrain Branch was held at the Awali Hall on 5 May.

The chairman announced that the following officers had been elected for 1958–59: chairman, H. G. Babbage; vice-chairman, R. J. Milne; hon. treasurer, R. A. A. Duncan; and hon. secretary, D. G. Johnstone.

The chairman introduced J. W. James of Bapco, who presented a paper entitled "Recent Seismic Surveys—Bahrain".

Mr James opened by saying that oil exploration resolved itself into a search for areas in which three special geological conditions existed, namely, source beds, reservoir beds, and traps or upfolds to trap the migrating oil and concentrate it in sufficient quantities to justify the expenditure of drilling for it.

After describing the early history of oil exploration on Bahrain, Mr James considered the history and application of the reflexion seismograph and then explained, by the use of detailed drawings, the functions of the various instruments involved and the practical application employed during the recent seismic survey in that area, both on land and on the surrounding coastal waters.

Mr James's conclusion was that the reflexion seismograph was a powerful exploratory tool in areas where direct observation of subsurface structure was not possible, but it must be emphasized that it had very definite limitations. At best, it must be translated into geological data. It was a great help in the preliminary steps leading to the discovery of an oil deposit, but it did not find oil. Oil could only be discovered by drilling.

Coloured slides of the recent seismic surveys concluded the paper and a vote of thanks to the author was proposed by R. E. de Mestre.

The attendance was 60, the highest on record for an ordinary meeting since July 1956.

J. W. James addressing the Bahrain Branch

Visit to *Caltex Brussels*

On 7 May thirty-six members of the Branch and their wives paid a visit to the tanker *Caltex Brussels* at the Sitra Anchorage.

From the meeting-point outside the Bahrain Petroleum Co.'s main office at Awali the party travelled by bus to the Sitra Wharf and by launch to the tanker.

Refreshments were served on board *Caltex Brussels*, while the master, Captain Groeneveld, introduced his officers to the party. A conducted tour of the vessel followed. Of special interest were the echo sounder and radar set and, after a little instruction, the visitors were permitted to test their skill on these apparatus, with very mixed results!

The engine room was another attraction and great interest was shown in the various storerooms, galley, and other rooms which were inspected.

The sun had set when a very reluctant departure was made. H. C. Babbage, chairman of the Branch, expressed to Captain Groeneveld and his officers the thanks of the Branch for their hospitality and for all the efforts they had made to ensure the success of the visit.

The Branch also thanks George Beeby Thompson (a past-chairman of the Branch) and Captain Arnesen of Caltex Marine Department for their excellent organization of this most pleasant visit.

Fawley Branch

A meeting of the Branch was held at the Sports Centre, Esso Refinery (Fawley) on 14 March.

The chairman, S. A. Berridge, introduced J. R. Baddiley, lately head of Esso Refinery (Fawley) Equipment Inspection Division, who spoke on "Non-destructive Inspection of Materials".

Mr Baddiley said that non-destructive inspection covered a wide field, beginning with human senses such as sight, smell, and touch. In the engineering and scientific fields, non-destructive inspection equipment ranged from simple micrometers to complicated electronic devices.

Inspection was necessary in connexion both with fabrication and maintenance. No fabricated article was perfect; experience dictated the permissible degree of error or magnitude of defect and inspection ensured that the limits were not exceeded. In service equipment deteriorated, and inspection was used to predict remaining life and to ensure safety.

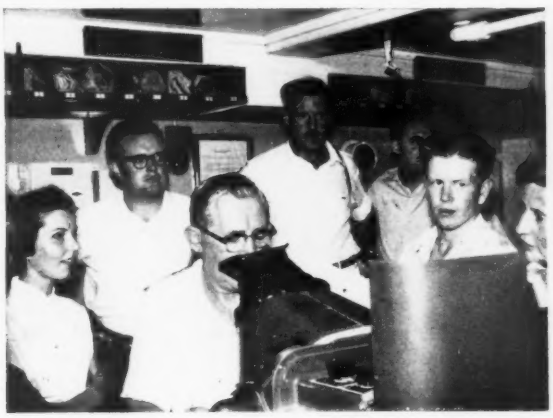
Without the aid of non-destructive testing, certain defects could not be found with any degree of certainty. Examples were porosity in castings and cracking in compressor parts.

The speaker stated that, in his experience, the main

BAHRAIN BRANCH ON BOARD "CALTEX BRUSSELS"

While H. Babbage and Denis Johnstone, chairman and honorary secretary respectively of the Branch, view the horizon with obvious interest, Tom Parks, Lester Kelly, and Ken Crowe (right) *share a joke and partake of nourishment. In the background* (left) *is Mrs Clark and P. Clark with his back to the camera*

On the left are seen M. Stewart, S. Thomas, H. Babbage, J. Thackeray, and Dick de Mestre receiving some tips on navigation. In less serious mood (right) *Walford Morgan, Mrs H. Babbage, Mrs L. Kelly, Mrs S. Thomas, Mrs W. Morgan, and Mrs K. Crowe partake of refreshment*



(Left) *Captain Groeneveld explaining the operation of the wheel to* (left) *H. Babbage and* (right) *B. Smythe, Mrs S. Thomas, and M. Stewart. In the right-hand picture, the Captain demonstrates echo sounding to Mrs W. Morgan, S. Thomas, H. Babbage, M. Runechles, P. Clark, and Mrs George Beeby Thompson*

uses for non-destructive inspection in petroleum refinery engineering, lay in thickness measurement, crack detection, and the identification of porosity and other internal defects.

Then followed a description, in simple terms, of the basic principles of a number of non-destructive inspection instruments. A variety of physical principles were involved. The instruments included ultrasonic thickness gauges and flaw detectors, magnetic thickness gauges, thickness gauges involving the use of radioisotopes, magnetic crack detectors, and the use of X-rays and gamma rays for the location of welding defects.

All the instruments had their uses and limitations. Ultrasonic gauges were versatile but had a temperature limitation; the magnetic thickness gauge could be used on hot surfaces but had a very limited thickness range. X-ray machines generally produced better radiographs than did radioisotopes, and were dangerous only when exposures were taking place; radioisotopes were more portable but must be treated very carefully at all times.

An increase in non-destructive inspection was being made in efforts to improve inspection and to reduce downtime of plants by eliminating the need for dismantling. There was much room for development.

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Books and Films

Wear

Produced by an honorary editorial board of representatives from six countries, under the editorship of G. Salomon of Delft, a new technical bi-monthly entitled *Wear* commenced publication in August last.

Each issue is composed of a number of technical and scientific papers on various aspects of the problems of wear, friction, and lubrication. Leading authorities from all over Europe, Russia, and America have contributed to the first four issues.

The periodical, which is profusely illustrated, contains also some articles in French and German, abstracts of current scientific literature in English, and a calendar of forthcoming events.

Wear is published by Elsevier Publishing Co., Amsterdam, and the subscription for the annual volume of six issues is £5 7*s*. 6*d*.

Esso Review of 1957

Large but simple coloured graphs and charts and a lucid colloquial style of writing combine to distinguish Esso Petroleum Co. Ltd's *Annual Review* 1957 from many a more staid company report. Colour is also used effectively to highlight salient facts in the text and the illustrations help to provide an easily assimilated account of the year's activities.

Written, perhaps, to appeal most to the Company's staff—as exemplified by the chairman's foreword addressed explicitly to "Our Employees" and by the detailed statement of the Company's business principles—the booklet is nevertheless packed with facts.

A particularly significant feature of the Company's trading during the past 12 months in Britain is that despite a reduction in total consumption of petroleum products, Esso's share of the market showed an increase. Net profit also increased and an interesting chart demonstrates how the Company's total receipts of £228,657,000 for 1957, after payment of taxes, material, transport, and labour costs, produce a net profit of less than 5 per cent of that total. Refinery expansion continued and throughput at Fawley, at 8,199,000 tons, was a record. Interesting details are given of the cost to the Company of the Suez crisis and the variation of route of crude supplies that it entailed.

In a report where so much emphasis is laid on staff welfare it is not surprising to find a whole section devoted to "People and the Company". This deals with training schemes, the Company's pension plan, long-service awards, joint consultation committees, and a "Coin your Ideas" scheme.

The Company's declared policy is that competitive private enterprise is the best and most flexible means of providing a community with the goods and services it needs. But private enterprise, to be successful and beneficial, depends on the initiative, enthusiasm, and resourcefulness of the individual. This is emphasized in the final article which ends with the injunction "we must each make saving for the future our personal concern".

Kuwait Oil Co. in 1957

From the title on the front cover to the last words in the text, the annual report of the Kuwait Oil Co. to his highness the Ruler of Kuwait is printed in English and Arabic. The use of the two languages emphasizes the partnership which the Company, since its inception, has maintained with the people of Kuwait. The introduction expresses the Company's appreciation of the co-operation and counsel of the Ruler of Kuwait and this theme of mutual goodwill and understanding is continued throughout the report.

Much of the technical data and information on engineering construction carried out during the year has already appeared in the article on *Kuwait Oil* in the May *IP Review*, so it is sufficient here merely to refer to those advances made by the Company for the welfare of its labour force. The Company's policy of increasing the number of Arabs in staff categories was pursued both by promotion from within the Company and by recruitment from neighbouring Arab countries. At the end of 1957 the number of Arabs employed in the two staff grades had increased by 11·25 per cent. Amongst new amenities introduced in the past twelve months were a general wage increase, marriage gratuities for Kuwaitis, and a club for Arab employees. More than 200 houses were constructed and special attention was paid to improvements in the residential area of South Ahmadi. Some impression of these improvements is gained from a coloured aerial photograph of a new housing estate at Ahmadi, where the pleasant red-roofed bungalows lend a touch of colour to the sombre landscape, by a view of Ahmadi showing the attractive main office of the Company with a praiseworthy number of lawns and small trees visible, and by an illustration of the Arab Families Clinic at Ahmadi.

Although the report contains much information on output, prospecting, and sales, it is most notable perhaps in demonstrating the benefits which an oil company, in co-operation with a wise ruler, can bring to the inhabitants of a previously under-developed area.

Royal Dutch/Shell Activities

Last year the Royal Dutch/Shell Group celebrated its fiftieth anniversary. This epoch in the Group's history is given special prominence in the *Survey of Activities* 1957, issued by the "Shell" Transport and Trading Co. Ltd.

Half-a-century's progress and achievements are not easily condensed into an account contained in a 44-page book, but salient features of the Group's growth during the period are emphasized by contrast and comparison, both in the reading matter and in the graphic illustrations.

In 1907 practically all its production was derived from the Far East, but fifty years later crude supplies, which averaged 2·25 million b.d. in 1957, were drawn from fields in North and South America, Canada, seven countries in Europe, the Middle East, and Africa, and three countries in Asia. In 1907 refinery intake in the Group's five refineries in the Far East and one in Rumania averaged 20,000 barrels per day. In 1957 this had increased more than a hundredfold to 2·2 million barrels per day, processed in forty refineries in twenty-one countries. The Group's tanker fleet in 1907 totalled 150,000-dw tons; in 1957 this had become 8·5 million tons, and its carrying capacity was 85 times greater than its counterpart of 1907. Total sales of oil products also have shown a hundredfold increase from 1907 to 1957.

In addition to these historical data, the survey examines the Group's progress during the past year and notes trends in supply and demand.

The Group's world-wide ramifications are depicted in a map of both Hemispheres which shows the locations where member companies of the Group are currently operating. Virtually every major nation in the free world is the scene of some aspect of this Group's activities. Some visual indication of the difference in climatic conditions experienced by personnel working for the Company in the unremitting search for, and conveyance of, more and more oil, is provided by the frontispiece of welders working, under the protection of gay sunshades, on pipeline construction in Venezuela, and a party surveying an area of Canadian forest in snow and ice.

All the illustrations are in full colour, except for a series of nine in black and white, which in juxtaposition to coloured photographs of current activities, portray some of the advances made during the past fifty years.

Shell Films

The 1958 edition of *Shell Films* has recently been published. In more than 80 pages it catalogues all the Shell Petroleum Co.'s films that are currently available for international circulation. They are grouped under three headings—the petroleum industry, the world served by oil, and Shell Cinemagazines.

Selection of films for any special purpose is facilitated by the synopses, which are preceded by useful facts on the name of the production unit, the name of the director, the release date, and the running time. Each film is recommended as specially suitable for one or more types of audience, classified according to a general definition given in the introduction to the catalogue.

The Shell Company does not profess to have produced a film for every purpose and every taste, but it has covered a range of subjects beyond the confines of its interests. In addition to studies of the search for oil, refinery processes, construction of tankers, and the pattern for chemicals there are films dealing with principles of motor engine design, aviation, agriculture, and forestry.

Three titles, selected from the more general subjects, aptly illustrate the versatility of the Company's film productions. *Lord Siva Danced* is a study of classical dancing in India, *Malaria* relates the causes, symptoms, and prevention of the disease, and *How to Use a File* offers advice applicable to many people unconnected with the oil industry.

Most of the films are available in either 16 or 35 mm gauge, many are in colour, and one, *Power in Perspective*, is stereoscopic.

The catalogue is concluded by a short article on how to choose Shell films by Sir Arthur Elton, some specimen programmes, instructions on how to borrow the films, and an alphabetical list of available titles. Copies of the catalogue are available to representatives of organizations and applications should be made to: Film Section, Public Relations Department, Shell Petroleum Co. Ltd, 1 Kingsway, London, W.C.2.

Supplement to British Chemicals and their Manufacturers

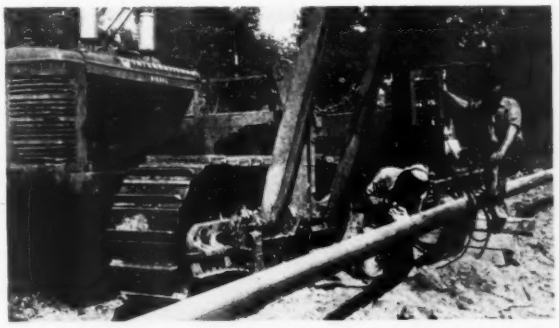
The 1958 supplement to the last edition of *British Chemicals and their Manufacturers*, which appeared in 1957, is now available. The supplement lists changes that have occurred in the biennial period that separates publication of each issue of the directory, which is produced by the Association of British Chemical Manufacturers.

Copies of the supplement are obtainable, free of charge, from ABCM, Cecil Chambers, 86 Strand, London, W.C.2.

Aluminium Pipe for Oilfield Use

Recently shown in London was the Aluminium Company of Canada's film *Put This in Your Pipe* featuring the laying of 16 miles of 6- and 4-inch aluminium pipe to convey water from the North Saskatchewan River to an Alberta oilfield. The line runs through clay, muskeg, and sandstone: aluminium was chosen on account of its resistance to corrosion. The 4-inch lines take the water to injection wells where it is pumped into the oil-bearing formation to increase ultimate production.

Also shown at the same time was *High-speed Aluminium Welding*, the title of which is sufficient to describe the particular topic illustrated. It was stated that during the laying of the pipeline referred to above, the speed of welding was such that the welding crews were at one time four miles ahead of the ditcher.



Welding the final pass with an inert metal arc machine. Alcan 3SF 4-inch and 6-inch pipe was used on this Canadian water-injection line

The Oil Industry in Canada

Significant figures of the progress of the oil industry in Canada during the past year are contained in *The Financial Post Survey of Oils* 1958, the 16th volume of which has recently been published by Maclean-Hunter Publishing Co. Ltd, 1242 Peel Street, Montreal, 2, at the price of $4.

In production of both crude oil and natural gas and in reserves of gas and oil there were substantial increases in Canada reported in 1957. New discoveries of major importance were made in the Virginia Hills-Swan and Hills-Kaybob area and in the Innisfail district of Alberta where large pools of oil are expected to be brought into production, and in the Peace River area of British Columbia.

The volume begins with a series of tables. These cover an 8-year range of prices of Canadian oil and gas stocks, crude oil production by fields for eight years past, producing fields with details of the API gravity, the age of the field, the number of the wells, and the well spacing in acres, and exports of petroleum products, including lubricating oil and mineral wax. Other tables deal with gas reserves, crude oil consumption, imports, capacities of operating refineries, and daily oil refinery capacity by provinces. This section is followed by a lengthy alphabetical review of oil and gas companies, which lists their production, capital, dividends, and officers. For many of the companies condensed balance sheets covering trading for three years are also included.

A series of maps of oil and gas areas, which show the location and type of well drilling or abandoned, form a very useful final section to the survey.

Copies of the survey are available in Britain from Maclean-Hunter Ltd, Wellington House, 125 Strand, London W.C.2, at the price of 30s. post free.

World Motor Gasoline Survey

Following the lines of previous editions, the 1958 edition of *World-wide Survey of Motor Gasoline Quality*, published by The Associated Ethyl Company Ltd, surveys the properties of the motor gasolines marketed in nearly 140 countries. The survey is based upon data obtained during the first two months of 1958 which is tabulated under nine main zones.

For each country for premium and regular grade fuels, and for super grades where applicable, details are given of octane number, TEL content, vapour pressure, specific gravity, sulphur content, and distillation characteristics.

Each zone has an outline map on which is indicated the highest Research octane rating for the gasoline marketed in each country. Useful conversion tables cover volume-weight, temperature, pressure, and TEL concentrations.

Passenger Car Data

The Associated Ethyl Company Ltd has recently issued its 1958 book of *Brief Passenger Car Data*. Essential characteristics are given of engine and auxiliaries and of chassis. Summarizing the characteristics of 78 engines, average standard compression ratio is 7·66, highest and lowest being 8·5 and 6·63 respectively.

Similar information on United States cars is given in another booklet issued by the Ethyl Corporation. Here the summary of the characteristics of 50 engines shows standard compression ratios as: lowest 7·8; average 9·47; highest 10·5.

Data for cars in France is likewise made available by Ethyl S.A. and for 25 types standard compression ratios are 6·5 lowest, 7·25 average, 8·5 highest.

Exhibitions and Conferences

Joint Conference on Mass Spectroscopy

A joint conference on mass spectroscopy, organized by the Hydrocarbon Research Group of the Institute of Petroleum and Committee E-14 of the American Society for Testing Materials, will be held in London from 24 to 26 September. The conference, which will be opened by Professor Sir Cyril Hinshelwood, President of the Royal Society, will take place in the William Beveridge Hall, Senate House, University of London.

There will be two sessions daily, from 9 a.m. to 12.30 p.m. and from 2 to 5.30 p.m. The sessions will deal successively with: high resolution mass spectroscopy, mass spectrometry of solids; application of the mass spectrometer in organic chemistry with regard to analysis and instrumental techniques; application of the mass spectrometer in organic chemistry with regard to mass spectra and their interpretation: ionization and electron impact studies; and use of mass spectrometer in fundamental research.

British speakers will include representatives from the Atomic Energy Research Establishment, Harwell, the U.K. Atomic Energy Authority, Capenhurst, Oxford, Liverpool, and London Universities, and leading industrial and commercial organizations. Papers will also be contributed by experts from Belgium, Canada, France, Germany, Netherlands, and U.S.A.

The language of the conference will be English and preprints of the 41 papers will be sent to registered members of the conference about two weeks before it opens. The membership fee is £4 for members in Europe and $15 for those outside Europe. Membership entitles each member to attend the conference and the conference reception. A conference dinner (fee £1 5s) will be held on 25 September.

Registration forms, which should be completed and returned by 1 August with remittances, can be obtained from W. J. Brown, organizing secretary, Mass Spectroscopy Conference, Metropolitan-Vickers Electrical Co. Ltd, Scientific Apparatus Department, Trafford Park, Manchester 17.

Second Liquid Fuels Conference

A Conference on "Major Developments in Liquid Fuel Firing 1948 to 1959", is being organized by The Institute of Fuel to take place in Torquay from Tuesday to Thursday, 12–14 May 1959, inclusive.

There will be five sessions, which will include papers on:

(*a*) Research into various aspects of liquid fuel firing.

(*b*) Boiler firing.

(*c*) Corrosion.

(*d*) Reviews of liquid fuel firing in the various industries (including domestic heating) over the past ten years.

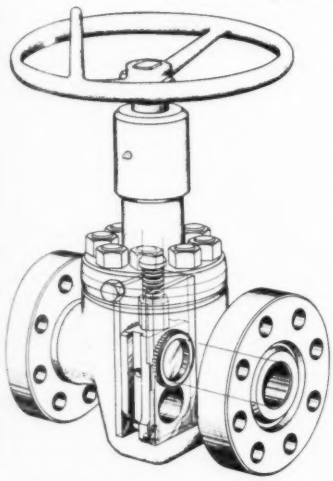
The conference will be in the nature of a summer meeting at which ladies will be very welcome. Full details will be issued later.

Standards Engineers Society Annual Meeting

The theme of the 7th Annual Meeting of the Standards Engineers Society of New Jersey, to be held in the Benjamin Franklin Hotel, Philadelphia, from 22 to 24 September, will be "Standardization—A Must for the Space Age".

Trade Literature, etc.

New Conduit-gate Valve



Two high-strength alloy-steel rings that rotate a fraction of a turn each time the gate is opened are the principal feature of the new type F conduit-gate valve being produced by Cameron Iron Works Inc., Houston, Texas. This feature is said to increase the life of the valve to many times that of the conventional valve, since wear is distributed over the entire sealing surface of the steel rings, instead of being confined to a small area at the bottom of the seat.

The new valve also has a smooth-bored conduit type gate to give an uninterrupted flow in the open position. This reduces turbulence to a minimum and keeps line fluids from entering the body.

The body cavity is packed with lubricant to ensure a tighter seal for the liquids or gases and to protect working parts against corrosion and damage from frost.

Models are available in a wide range of sizes and for pressures up to 15,000 psi.

Fluid-Heat Transmission Unit

Fluid heat transmission provides an effective means of obtaining temperatures up to 300 C at atmospheric pressure, compared with the pressures up to 1500 psi needed if steam is used for the same temperatures.

A new two-colour illustrated leaflet describes a range of fluid heat transmission units manufactured by the Beverley Chemical Engineering Co. Ltd, London Road, Horsham, Sussex, from whom further details can be obtained.

Paper Towelling for Many Uses

Paper towelling has many uses other than for the normal purposes of the washroom. Many of these uses were recently demonstrated by the makers of Hi-Dri paper towelling, the Industrial Division of Kimberley-Clark Ltd. In engineering shops and manufacturing plants, its use for the removal of excess oil and grease is only one of these purposes. Wet or dry it readily absorbs oil or water and does not fluff, an important aspect where delicate components are involved.

In industrial canteens and similar establishments, this product has also innumerable uses, including the drying of crockery and the polishing of glassware without leaving any fluff. Incidentally, Hi-Dri has an excellent wet strength—it can support a 4-lb weight although saturated with water. It is available in various packs, from the individual towel to 250-ft rolls of 18-inch width. Details are obtainable from the Company at 11 Grosvenor Gardens, London, S.W.1.

Mobile Stand to Show Fire-safe Insulation

A mobile exhibition stand displaying Asbestolux non-combustible asbestos insulation board and Rocksil rock wool insulation has been put into service by Cape Building Products Ltd, Park Street, London, W.1.

The stand will tour trade fairs and industrial centres throughout Britain to give guidance to industrialists on the problems presented by the Thermal Insulation (Industrial Buildings) Act. Later this year it will visit the Building Exhibition in Oslo.

The stand emphasizes the fact that only non-combustible materials provide the degree of fire protection demanded by modern factories.

Alkylation Plant Started Up at Pernis

An alkylation plant has recently been started up at Shell's Pernis refinery, Rotterdam. This is the first such plant in Western Europe and forms part of the fifth phase of the refinery's post-war expansion programme. Installation of the new plant permits production of aviation gasoline, which formerly had to be imported.

New Oil-Burner Company Formed

Gas-oil burners manufactured by the Airoil Burner Co. of America are now to be made in Britain by a newly formed Company, which is to be known as The Airoil Burner Company (G.B.) Ltd. The offices of this new Company are at 123 High Street, Uxbridge.

Mobil Helps to Stabilize *Queen Mary*

During her recently completed winter overhaul the Cunard liner *Queen Mary* was fitted with the new Denny-Brown stabilizers.

The Mobil Oil Co., who are sole suppliers of lubricants for the main engines of both *Queen Mary* and *Queen Elizabeth*, provided also the oil necessary for the operation of the stabilizers. Thirty-six barrels of Mobil DTE marine oil heavy were needed for the initial fill-up.

New Instrument Company in London

From 1 May a new instrument Company, Research and Control Instruments Ltd, 207 Kings Cross Road, London, W.C.1 (Telephone: TERminus 8444) has been sole U.K. distributors for electronic instruments and scientific equipment hitherto marketed by Philips Electrical Ltd (Research & Control Instruments Division).

The new Company is also U.K. distributor for industrial X-ray equipment manufactured by C. H. F. Muller AG, Hamburg, and for Norelco (U.S.A.) X-ray diffraction and spectrographic equipment.

The Company is sole distributor for sale and servicing of Mullard electronic measuring instruments and electro-chemical apparatus in the U.K.

New to the British market are electronic instruments made by Elektro-Spezial AG, Hamburg, and handled by the new Company.

Mobile Exhibition Features Industrial Valves

A mobile showroom displaying industrial valves and fittings manufactured by Newman, Hender & Co. Ltd, Woodchester, has left on a six-month tour through France Italy, Switzerland and Western Germany.

Factories will also be visited and in some areas the mobile showroom will be parked on a central site to allow easy inspection of the range of forged steel valves and fittings, lubricated parallel plug valves, self sealing conduit gate valves, and Vee-Reg regulation stop valves. In addition some bronze and cast-iron valves are on show.

The showroom last year toured Belgium, Holland, Denmark, and Sweden. Prior to this it had visited England and Scotland and some areas of Wales.

Mobile Mud Tanks for Venezuelan Oilfields

First of their type, two of the largest mobile tanks ever designed to carry drilling mud were shipped recently to Compania Shell de Venezuela Ltd for use in the oilfields. Each cost about £7000 and consists of a 4500-gal vacuum tank with engine and compressor mounted on a 50-ton semi-trailer of special design.

The tanks, which are 27 ft long and 6 ft in diameter, were made to Shell's requirements by Bristowes Machinery Ltd. Filling is by vacuum and discharge by compressed air at 30 psi. The reciprocating compressor is coupled to a Perkins S6 diesel engine, and both units are carried on the raised front deck of the semi-trailer.

The trailer, built by R. A. Dyson & Co. of Liverpool, has a dropped frame to ensure a low centre of gravity, and is designed to be towed by a Scammell 6 · 6 tractor. Coupling and uncoupling is facilitated by hydraulic landing gear that can support the front end of the semi-trailer even when fully loaded. A full-width landing pan avoids sinkage of the unit when uncoupled on soft ground.

New Flame-Failure and Ignition Controllers

Two new flame-failure controllers have been added to the Ether range. Both are designed to combat running flame-failure in gas or oil-fired systems: the first is semi-automatic and the second is a fully-automatic relight unit.

A revolutionary feature of these controllers is their method of "seeing" the flame in furnaces. Instead of using sensing electrodes, the controllers employ an infra-red-sensitive photo-cell (protectively housed and fitted with a toughened glass lens). This cell reacts instantly to flame failure and an electronic control unit immediately shuts off the fuel supply. The controllers are sensitive only to flame and ignore radiation within the heating chamber.

Power Steering for Straddle Carriers

The British Straddle Carrier Co. Ltd, 95 Wigmore Street, London W.1, have introduced power steering as a standard feature of their straddle carriers, which are designed to handle long and bulky loads.

The new steering improves manoeuvrability, reduces driver fatigue, and increases speed of handling. The new steering can also be fitted to carriers already in service and a special conversion kit is available.

New London Offices for Audley Engineering Co. Ltd

The Audley Engineering Co. Ltd of Newport have transferred their London offices from Caxton Street to 60–61 Trafalgar Square, W.C.2. The new telephone number is TRAfalgar 4401–3.

Also accommodated at this address will be Serck Radiators Ltd and Serck Tubes Ltd.

Gulf Eastern Co. London Office

Gulf Eastern Company, a wholly owned subsidiary of Gulf Oil Corporation, has acquired for its London office, from The Land Securities Investment Trust Ltd, a long lease of the second to sixth floors and basements of Portman House, Oxford Street, London, W.1, which is to be known as Gulf House.

American Heat Exchangers to be Made in Britain

An agreement has been signed between A. F. Craig & Co. Ltd, Paisley, Scotland, and Hudson Engineering Corporation, Houston, Texas, for the former Company to manufacture under licence in Britain the Hudson range of air-cooled heat exchangers.

Change of Name for E. B. Badger & Sons Ltd

From 1 May E. B. Badger & Sons Ltd announce that the name of their Company has been changed to Stone & Webster Engineering Ltd. Their U.K. address, at 20 Red Lion Street, London, W.C.1, is unaltered, but their overseas subsidiaries in Australia, France, and the Netherlands, will all bear the new name of Stone & Webster Engineering, in place of the former name of E. B. Badger & Sons.

Situations Vacant

AIR MINISTRY WORKS Design Branch requires, in London, **Designer Draughtsmen** for **Bulk Petroleum Storage and Pumping Installations** experienced in one or more of the following:—(a) Storage tank layout and design (b) pump house and plant layout (c) development of pipeline schemes (d) hydraulic calculations. Technical training to O.N.C. standard required. Salaries up to £1015 p.a. Starting pay dependent on age, quals., and exp. Long-term possibilities with promotion and pensionable prospects. 5-day week, 3 weeks 3 days leave a year. Normally natural born British subjects. Write stating age, quals., employment details including type of work done to any Employment Exchange quoting order No. Borough 105.

The proprietor of British Patent No. 650,286 for "Improvements in Methods and Means for Guiding Floating and Cementing Well Casing in Bored Holes" desires to grant manufacturing licences or to make other arrangements on reasonable terms, for the purpose of working the invention in this country. For further particulars apply in the first instance to Mathys & Squire, 52 Chancery Lane, London, W.C.2.

Progressive and Growing

AMERICAN-DUTCH COMPANY

engaged in design and construction of petroleum refineries and chemical plants requires

ENGINEERING SALES EXECUTIVE

with first-class educational background, convincing manner, ability to inspire confidence, fluent French or German.

If you have capacity to speak and write effectively and if you are interested in applying your talents in dealing with top-level executives in large oil and chemical companies, then we invite you to write us, giving a résumé of your education and experience. Your reply will be held in strict confidence.

This position requires that you be free to travel abroad. It offers opportunities for advancement into management position with good starting salary.

Applicant must have had process engineering sales experience in petroleum refining or chemical industries.

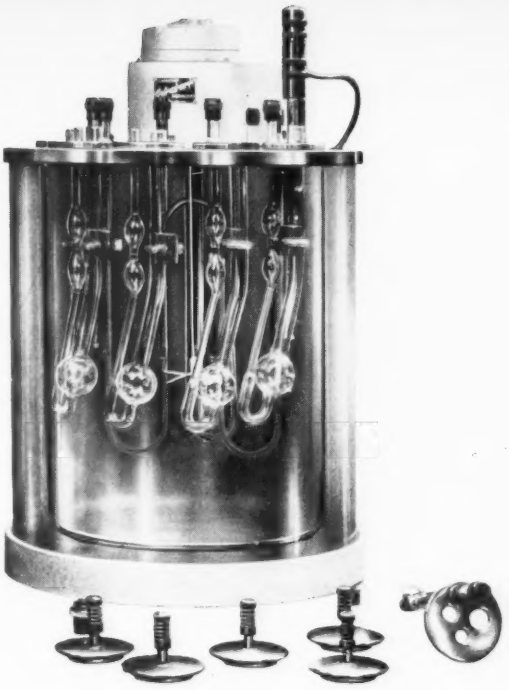
Badger N.
Comprimo V.

Mauritskade 39, The Hague, Holland.
Attention: General Manager.

GALLENKAMP VISCOMETER BATHS

for kinematic viscosity determinations

Suitable for methods described in IP 71, BS 188 and ASTM D445



Two types are available, one being a single-walled glass vessel for a nominal maximum temperature of 100 F but capable of successful operation at 140 F. The other is double-walled, comprising one glass vessel inside another and designed for a maximum temperature of 210 F. This model can be used at lower temperatures, if required. Both can be fitted with a cooling coil for circulating a cooling liquid when the ambient temperature rises above the required setting. Five viscometers can be accommodated. Accuracy of control is within ± 0·025 F. at all temperatures and approaches 0·01 F at 100 F.

Other applications include the calibration of thermometers, density and specific gravity measurements and the liquid from the bath can be pumped through external apparatus such as refractometers or polarimeters.

ASK FOR DETAILS

Gallenkamp *Supply the world's laboratories*

A. GALLENKAMP & CO. LTD., SUN STREET, LONDON, E.C.2 | *Telephone:* Bishopsgate 0651 *Telegrams:* Gallenkamp, Stock, London

BENZOLE

the spirit of British Industry

Benzole, the all-aromatic hydrocarbon, is made here in Britain by our own basic industries. For benzole, the essence of coal, is produced wherever coal is carbonised—at collieries, at gas works, and at our great iron and steel works.
Benzole is the spirit of British Industry. It is also the basis of two powerful motor spirits—

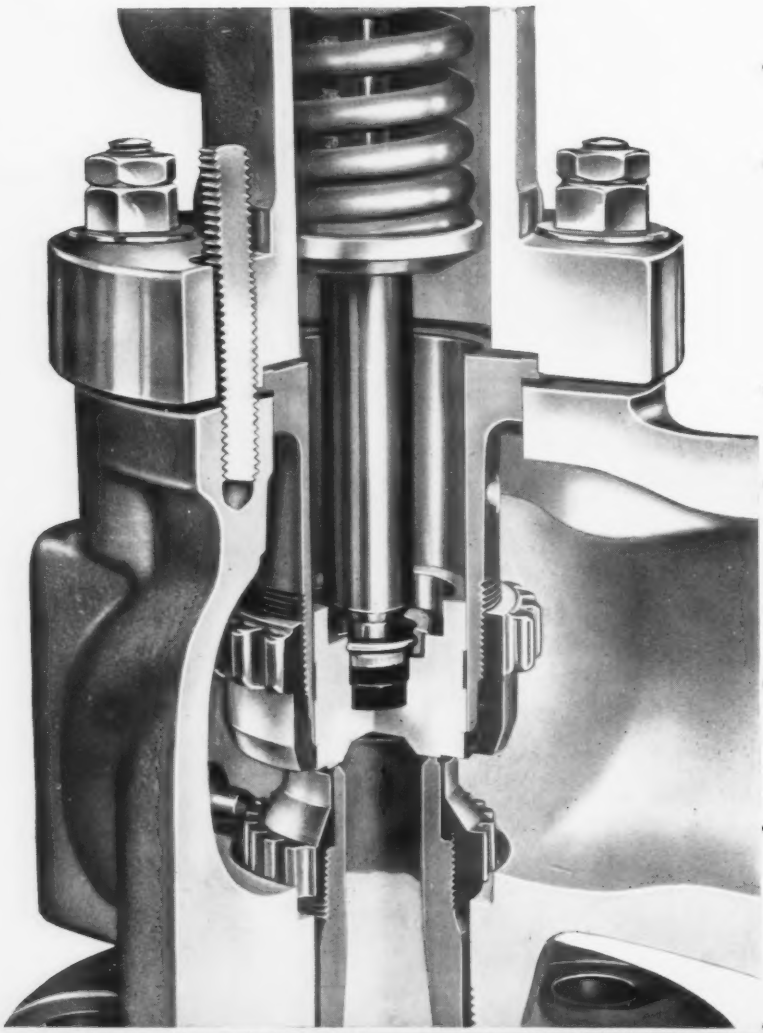
NATIONAL BENZOLE MIXTURE *and*

SUPER NATIONAL MIXTURE

National Benzole Co. Ltd., Wellington House, Buckingham Gate, London, S.W.1.

OUTSTANDING FEATURES OF THE CROSBY RELIEF VALVE

TYPE JO-35



1 Flat seats on both nozzle and disc lapped to optical flatness ensure bubble tight shut-off and facilitate maintenance when required.

2 Adjusting rings on both nozzle and guide ensure positive opening and closing and give optimum control over lift and maintain blow down to within 3 to 5%.

3 Fully circumferentially guided disc always ensures positive parallel action.

4 Hardened stainless steel pad and ball spindle point at lowest point of disc for accurate alignment.

5 Standard materials — steel body, stainless steel trim: nozzle, disc, guide, adjusting rings, spindle. Alternative materials available as specified.

6 Inlet connection to valve is made on nozzle flange. Fluid in contact only with nozzle and disc when valve is closed.

THE CROSBY VALVE AND ENGINEERING CO LTD

CROSBY WORKS, EALING ROAD, WEMBLEY, MIDDLESEX, ENGLAND. TELE: ALPERTON 2311

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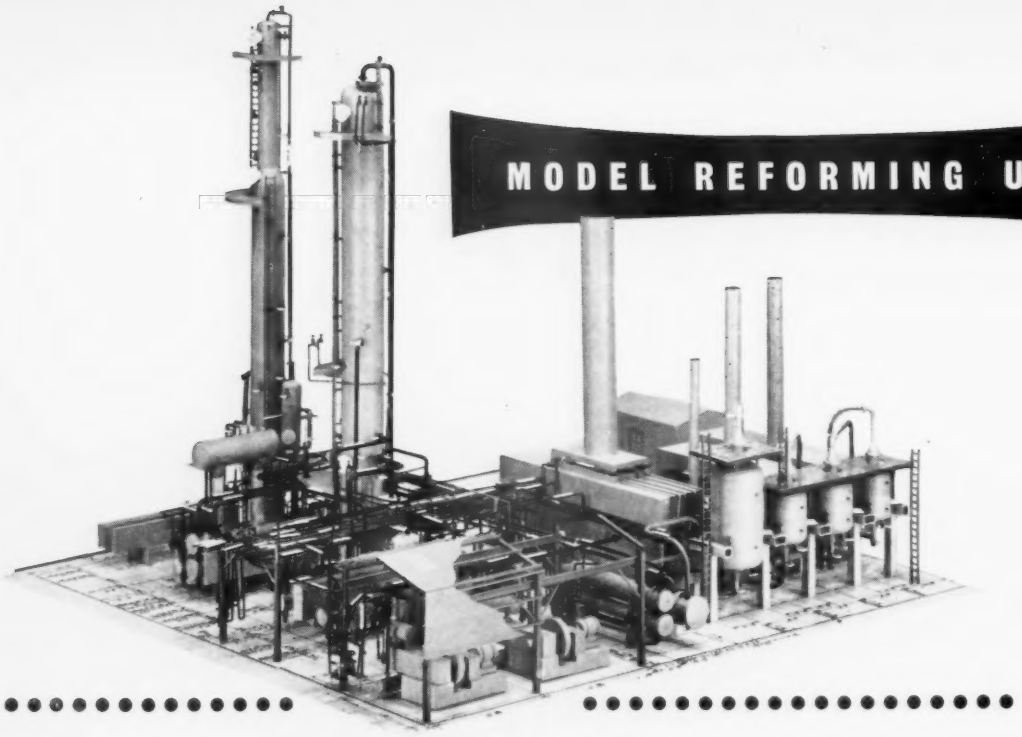

This scale model of a Kellogg catalytic reforming unit designed for Sinclair-Baker catalyst illustrates the detailed thoroughness of Kellogg services. The Kellogg organisation has developed a wealth of experience in engineering and constructing a large number of reforming units of different capacities using as many as seven different catalytic reforming process designs. The most recent Kellogg design for the highest octane reformates utilizes the Sinclair-Baker catalyst.

The Kellogg organisation can deliver the precise catalytic reforming unit required for any specific individual refinery situation. The most recent example of this service was to design a unit which can operate on either of two different catalysts depending on the reformate octane requirements. Refiners are invited to discuss with the Kellogg International Corporation the various applications of catalytic reforming process designs and the engineering changes necessary to modify their existing reforming units to accommodate an alternate catalyst required for higher octane reformates.

Kellogg International Corporation

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PETROLEUM REFINERIES
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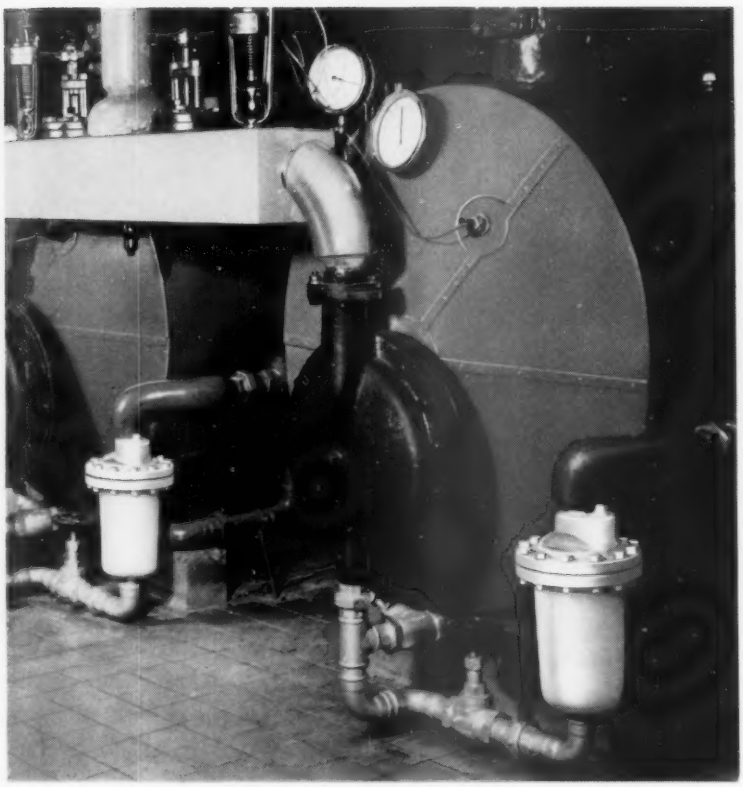
THE CHEAPEST TRAP
IS THE ONE THAT TRAPS THE BEST
NEEDS NO SERVICING
COSTS NOTHING FOR MAINTENANCE



Because the Drayton/Armstrong lever system is virtually frictionless, it has almost unlimited life.

Because of its high leverage, it will handle more condensate than any other trapping system, size for size.

Because it goes on for years and years doing its job efficiently without any attention or maintenance, the one trap that can be installed and then forgotten is the Drayton/Armstrong.

Because of this, it is not only the best trap but also the cheapest.

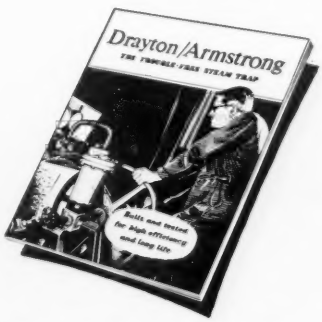
DRAYTON/ARMSTRONG BUCKET TRAPS

VERTICAL
½" to 2"
Available with cast-iron, cast-steel, gun-metal or forged steel bodies and covers

HORIZONTAL
½" to 1¼"
Supplied only in cast-iron with screwed inlet and outlet

ANGLE
½" only
The angle trap is available cast-iron screwed pattern only

BELLOWS-VENTED
½" to 1¼"
Available in cast-iron construction only



The Drayton Trap Book tells you all you want to know about steam trapping and Drayton traps in particular. A copy will gladly be sent you on application to Dept. P.R.

DRAYTON Steam Traps

THE DRAYTON REGULATOR & INSTRUMENT CO. LTD.,
WEST DRAYTON, MIDDLESEX *(Tel.: West Drayton 4012)*

DA59

BP MAPS THE FUTURE

Minutes saved in fuelling an aircraft mean a quicker journey for its passengers. Here, at Lisbon Airport, a BP man connects a mobile dispenser to the hydrant pit of the underground pipeline. The huge plane will be completely fuelled in about 15 minutes.

1000 Gallons a Minute

ASTONISHING FUELLING SYSTEM SPEEDS THE WORLD'S AIRLINES

AIRLINERS HAVE A MAMMOTH THIRST. Today's biggest planes need as much as 15,000 gallons when they are fuelled. Tomorrow's planes will need 'fill-ups' of 20,000 gallons.

How to deliver such enormous quantities of fuel safely and at high speed sets a new problem. But that problem is being solved. Solved by the Hydrant System which, with the advice of BP, is being installed at an ever increasing number of the world's major airports.

HOW IT OPERATES

Previously, fuel was always brought to an aircraft by a mobile tank fueller. Now, with the Hydrant System, it may be piped from the airfield depot direct to a hydrant on the concrete apròn. From the hydrant the fuel passes to a mobile fuel dispenser which filters and controls its flow, and from this to the aircraft waiting on the apron.

TORRENTIAL SPEED

The great advantage of the Hydrant System is that virtually unlimited quantities of fuel can be delivered at *torrential speed – with complete safety*. In principle the system is simple but (particularly because of the pressures set up) to make it practicable has involved an immense amount of research and experiment by BP technicians.

This new development in aircraft refuelling is just one more way in which The British Petroleum Company plans for the future – today.

THE BRITISH PETROLEUM COMPANY LIMITED

COOLING WITH AIR

A. F. CRAIG & COMPANY LIMITED

are the accredited sole manufacturers in the United Kingdom of the

'Hudson' Air Cooled Heat Exchangers

as designed and developed by the

HUDSON ENGINEERING CORPORATION HOUSTON, TEXAS, U.S.A.

Enquiries are therefore invited from Refining and other Process Plant Executives and Managers, their Purchasing Agents and all those interested in equipping their Plants with the most modern, efficient, economical and maintenance free units for this particular process.

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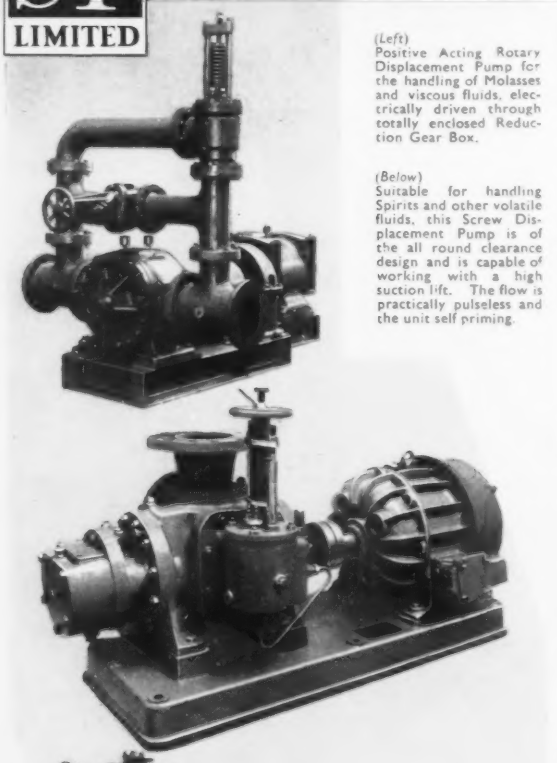
S&P PUMPS

LIMITED

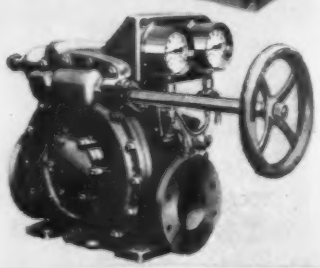
(Left)
Positive Acting Rotary Displacement Pump for the handling of Molasses and viscous fluids, electrically driven through totally enclosed Reduction Gear Box.

(Below)
Suitable for handling Spirits and other volatile fluids, this Screw Displacement Pump is of the all round clearance design and is capable of working with a high suction lift. The flow is practically pulseless and the unit self priming.



(Above)
Positive Acting Variable Output Guinard Rotary Piston Pump. Electrically driven through Reduction Gear Box, for Oils of varying viscosity.

(Right)
Reversing Flow Rotary Displacement Pump for fitting on tank wagons. These pumps are driven from a power take-off on the gear box.



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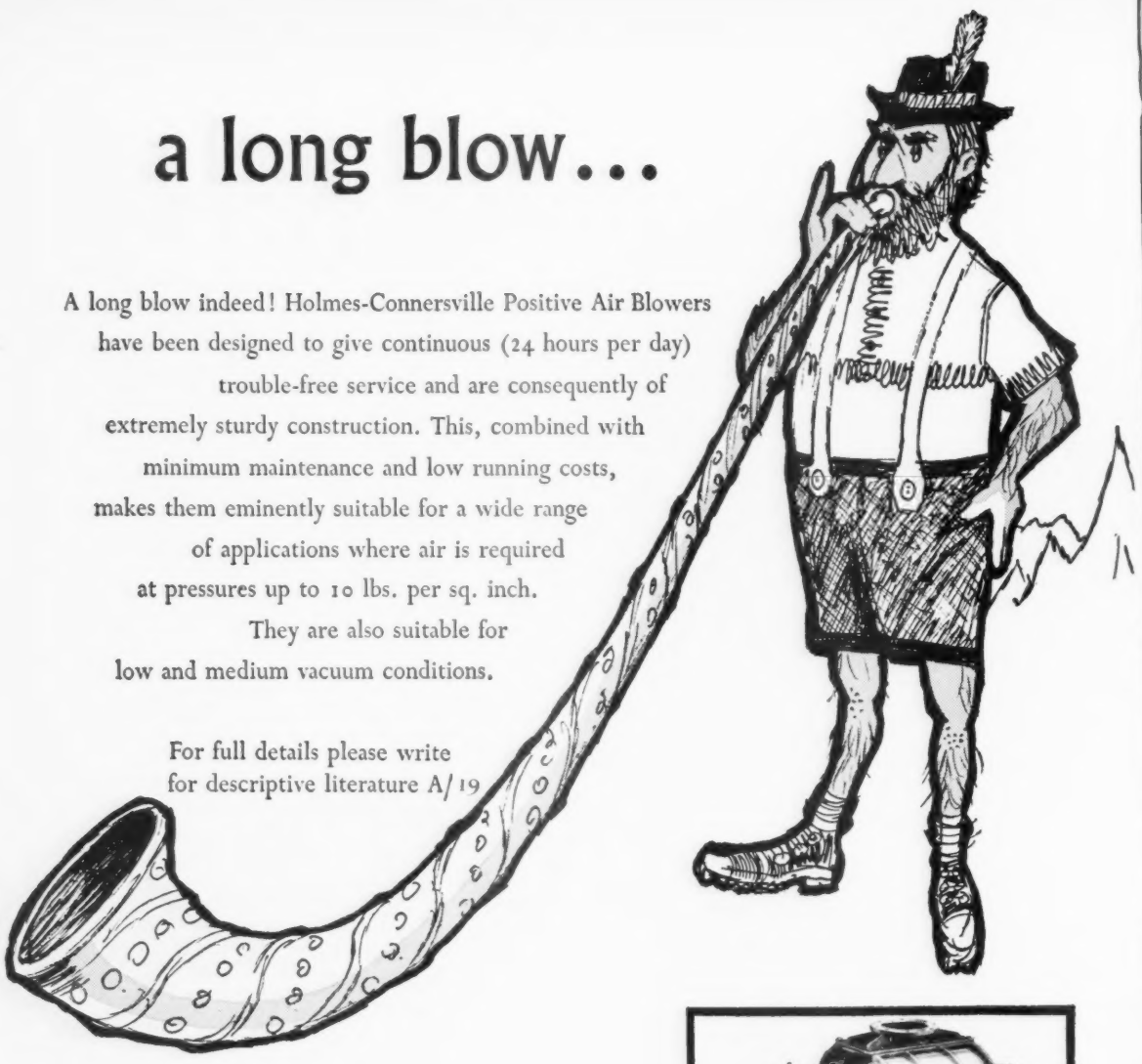

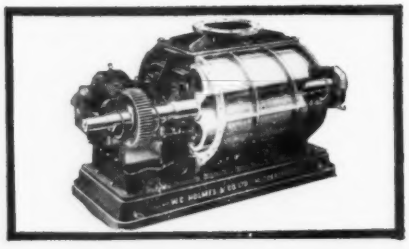

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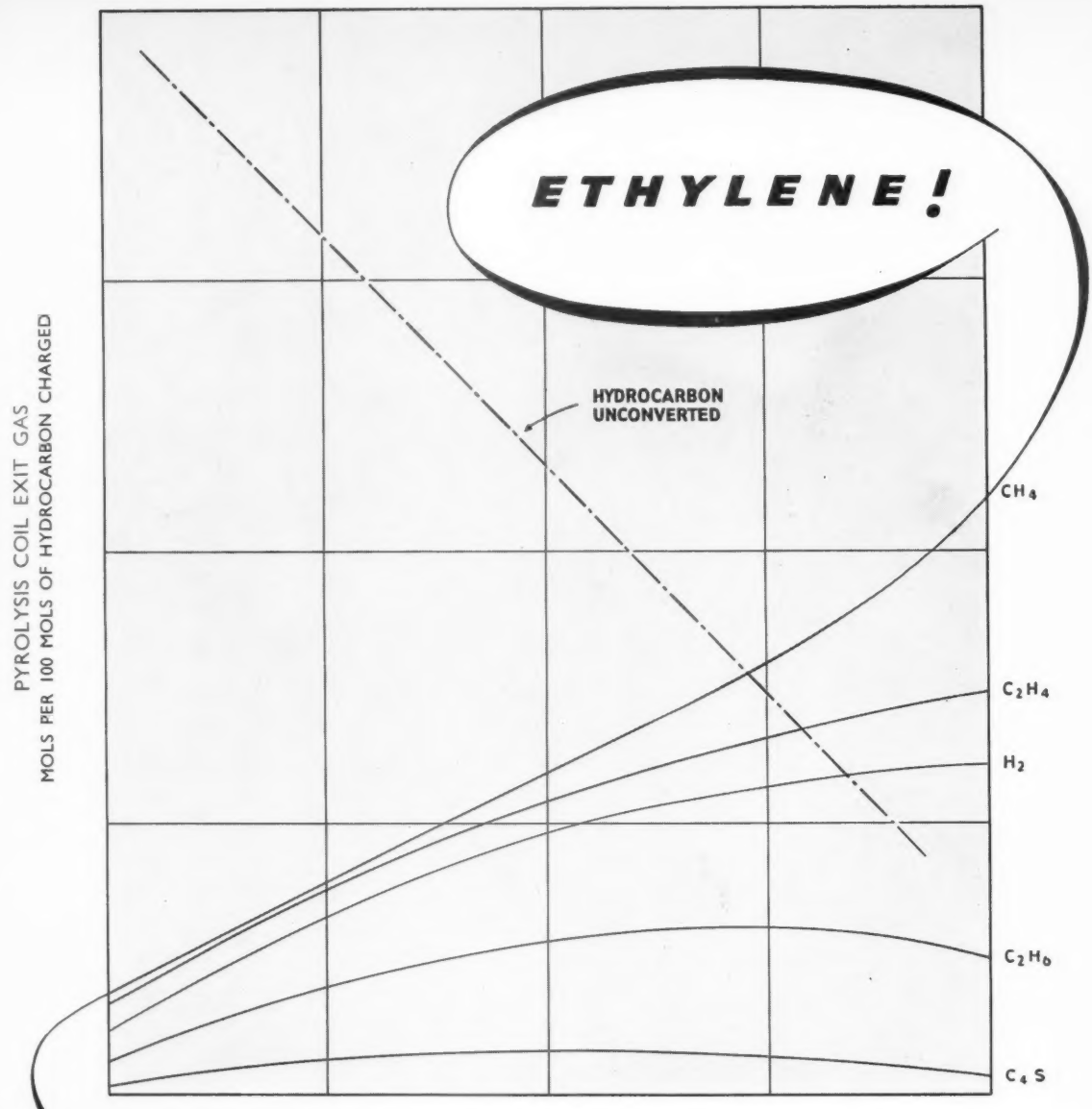

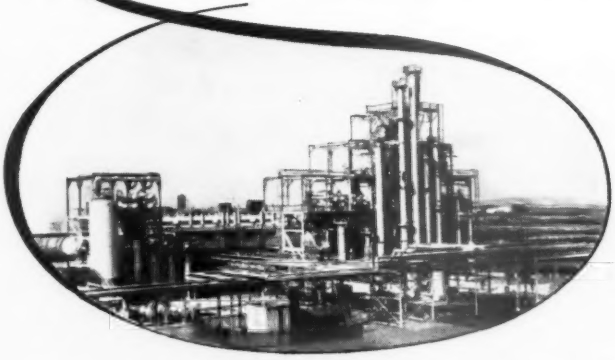

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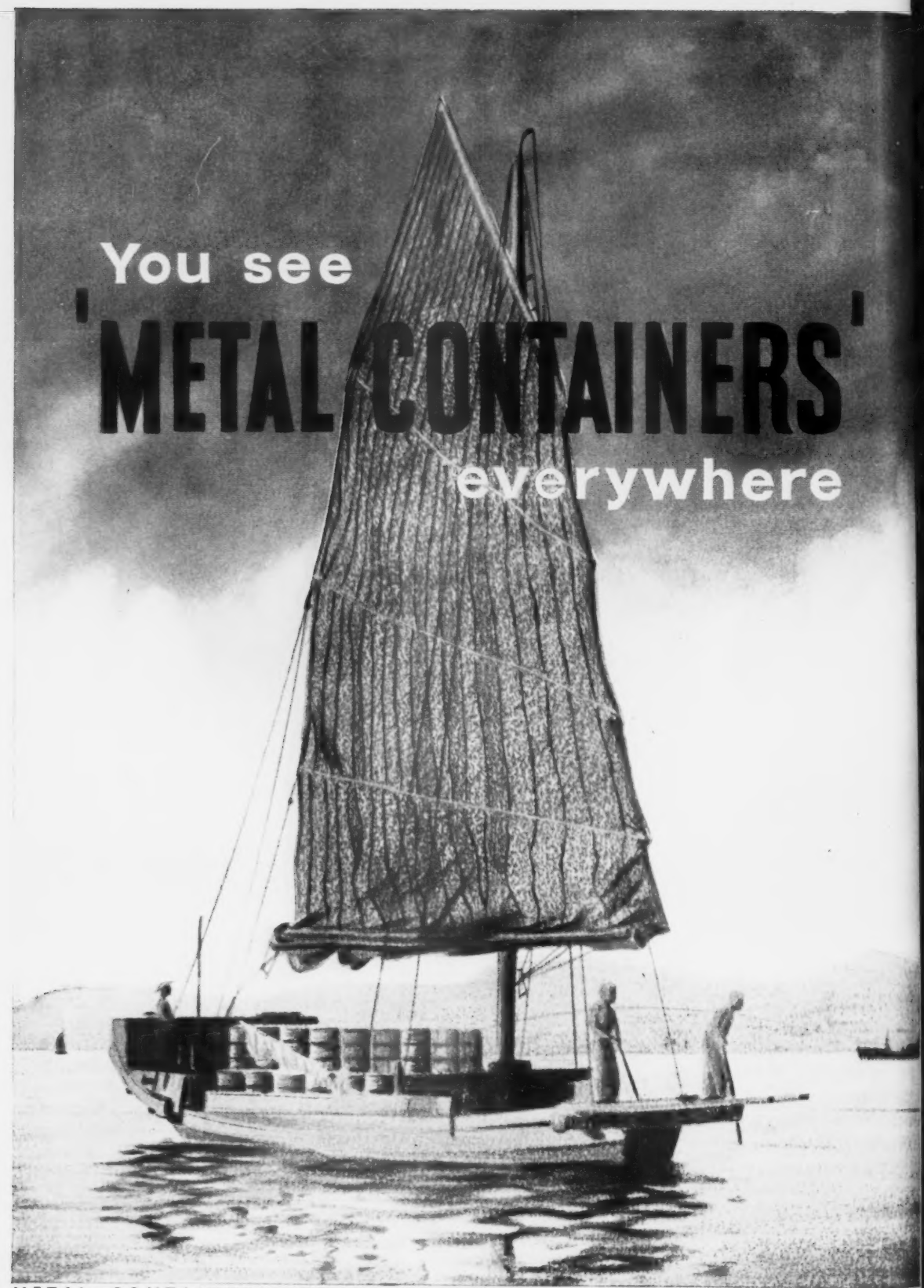

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